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Wang, L., Qu, J.J.

Satellite remote sensing applications for surface soil moisture monitoring: A review

(2009) *Frontiers of Earth Science in China*, pp. 1-11. Article in Press.

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Abstract

Surface soil moisture is one of the crucial variables in hydrological processes, which influences the exchange of water and energy fluxes at the land surface/atmosphere interface. Accurate estimate of the spatial and temporal variations of soil moisture is critical for numerous environmental studies. Recent technological advances in satellite remote sensing have shown that soil moisture can be measured by a variety of remote sensing techniques, each with its own strengths and weaknesses. This paper presents a comprehensive review of the progress in remote sensing of soil moisture, with focus on technique approaches for soil moisture estimation from optical, thermal, passive microwave, and active microwave measurements. The physical principles and the status of current retrieval methods are summarized. Limitations existing in current soil moisture estimation algorithms and key issues that have to be addressed in the near future are also discussed. © 2009 Higher Education Press and Springer-Verlag GmbH.

Author Keywords

monitoring; remote sensing; satellite; surface soil moisture

Document Type: Article in Press

Source: Scopus

Wang, K.^{a b}, Liang, S.^a

An improved method for estimating global evapotranspiration based on satellite determination of surface net radiation, vegetation index, temperature, and soil moisture

(2008) *Journal of Hydrometeorology*, 9 (4), pp. 712-727. Cited 1 time.

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Abstract

A simple and accurate method to estimate regional or global latent heat of evapotranspiration (ET) from remote sensing data is essential. The authors proposed a method in an earlier study that utilized satellite-determined surface net radiation (R_n), a vegetation index, and daytime-averaged/daily maximum air temperature (T_a) or land surface temperature (T_s) data. However, the influence of soil moisture (SM) on ET was not considered and is addressed in this paper by incorporating the diurnal T_s range (DT_sR). ET, measured by the energy balance Bowen ratio method at eight enhanced facility sites on the southern Great Plains in the United States and by the eddy covariance method at four AmeriFlux sites

during 2001-06, is used to validate the improved method. Site land cover varies from grassland, native prairie, and cropland to deciduous forest and evergreen forest. The correlation coefficient between the measured and predicted 16-day daytime-averaged ET using a combination of R_n , enhanced vegetation index (EVI), daily maximum T_s , and $DTsR$ is about 0.92 for all the sites, the bias is -1.9 W m^{-2} , and the root-mean-square error (RMSE) is 28.6 W m^{-2} . The sensitivity of the revised method to input data error is small. Implemented here is the revised method to estimate global ET using diurnal T_a range (DTaR) instead of $DTsR$ because $DTsR$ data are not available yet, although DTaR-estimated ET is less accurate than $DTsR$ -estimated ET. Global monthly ET is calculated from 1986 to 1995 at a spatial resolution of $1^\circ \times 1^\circ$ from the International Satellite Land Surface Climatology Project (ISLSCP) Initiative II global interdisciplinary monthly dataset and is compared with the 15 land surface model simulations of the Global Soil Wetness Project-2. The results of the comparison of 118 months of global ET show that the bias is 4.5 W m^{-2} , the RMSE is 19.8 W m^{-2} , and the correlation coefficient is 0.82. Incorporating DTaR distinctively improves the accuracy of the estimate of global ET. © 2008 American Meteorological Society.

Document Type: Article

Source: Scopus

Bolten, J.^a, Crowa, W.^a, Zhanb, X.^b, Reynolds, C.^c

Implementation of a global-scale operational data assimilation system for satellite-based soil moisture retrievals

(2008) *Proceedings of SPIE - The International Society for Optical Engineering*, 7085, art. no. 70850K, .

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Abstract

Timely and accurate monitoring of global weather anomalies and drought conditions is essential for assessing global crop conditions. Soil moisture observations are particularly important for crop yield fluctuations provided by the US Department of Agriculture (USDA) Production Estimation and Crop Assessment Division (PECAD). The current system utilized by PECAD estimates soil moisture from a 2-layer water balance model based on precipitation and temperature data from World Meteorological Organization (WMO) and US Air Force Weather Agency (AFWA). The accuracy of this system is highly dependent on the data sources used; particularly the accuracy, consistency, and spatial and temporal coverage of the land and climatic data input into the models. However, many regions of the globe lack observations at the temporal and spatial resolutions required by PECAD. This study incorporates NASA's soil moisture remote sensing product provided by the EOS Advanced Microwave Scanning Radiometer (AMSR-E) into the U.S. Department of Agriculture Crop Assessment and Data Retrieval (CADRE) decision support system. A quasi-global-scale operational data assimilation system has been designed and implemented to provide CADRE a daily product of integrated AMSR-E soil moisture observations with the PECAD two-layer soil moisture model forecasts. A methodology of the system design and a brief evaluation of the system

performance over the Conterminous United States (CONUS) is presented.

Author Keywords

Data assimilation; Microwave; Passive; Remote sensing; Soil moisture

Document Type: Conference Paper

Source: Scopus

Wang, L.^{a b}, Okin, G.S.^c, Macko, S.A.^a

Satellite prediction of soil $\delta^{13}\text{C}$ distributions in a southern African savanna

Journal of Geochemical Exploration, . Article in Press.

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Abstract

Stable carbon isotopes have been frequently used to indicate carbon pools and processes in soils, plants, and the atmosphere. Carbon isotope compositions are particularly useful in partitioning soil carbon sources between C3 and C4 vegetation because of the distinct $\delta^{13}\text{C}$ distributions for C3 and C4 vegetation. Remote sensing is a powerful tool used to identify ecosystem patterns and processes at larger scales. A union of these two approaches would hold promise for spatially continuous estimates of carbon isotope

compositions. In the current study, a framework is presented for using high spatial resolution remote sensing to predict soil $\delta^{13}\text{C}$ distributions across a southern Africa savanna ecosystem. The results suggest that if the vegetation-soil $\delta^{13}\text{C}$ relationship can be established, soil $\delta^{13}\text{C}$ distributions can be estimated by high-resolution satellite images (e.g., IKONOS, Quickbird). Despite limitations remote sensing is a promising tool to expand estimates of terrestrial $\delta^{13}\text{C}$ spatial patterns and dynamics. © 2008 Elsevier B.V. All rights reserved.

Author Keywords

Carbon; Isotope; Kalahari; Remote sensing; Soil

Document Type: Article in Press

Source: Scopus

Lee, M.S., Park, J.Y., Jung, I.K., Kim, S.J.

Estimation of spatial soil loss using the land use information of quickbird satellite imagery

(2008) *American Society of Agricultural and Biological Engineers Annual International Meeting 2008*, 4, pp. 2258-2267.

Konkuk University, Department of Rural Eng., 1 Hwayang-dong, Gwangjin-gu, 143-701 Seoul, South Korea

Abstract

This study is to estimate the yield and spatial distribution of soil loss using the 5 m land use data produced from QuickBird satellite imagery. For a small agricultural watershed (1.21 km²), a precise agricultural land use map were prepared using QuickBird satellite image of 1st May of 2006. RUSLE (Revised Universal Soil Loss Equation) was adopted for soil

loss estimation. To grasp the meaning of QuickBird soil loss, the result was compared with 10 m (1:25,000) ME (Ministry of Environment) and 30 m Landsat land use data. The average soil loss estimation results showed the 5 m QuickBird, 10 m ME, and 30 m Landsat land use were 1.65, 1.64, and 4.45 kg/m²/year respectively. It was mainly caused by the different LS factors of upland crop and paddy field. Especially the LS factors for the 10 m and 30 m resolutions were seemed to overestimate in spite of the terrace practice type of paddy.

Author Keywords

Land use information; Quickbird satellite image; RUSLE; Spatial soil loss

Document Type: Conference Paper

Source: Scopus

Maselli, F.^a, Gardin, L.^b, Bottai, L.^c

Automatic mapping of soil texture through the integration of ground, satellite and ancillary data

(2008) *International Journal of Remote Sensing*, 29 (19), pp. 5555-5569.

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Abstract

Satellite images obtained in the optical domain can provide information on important soil properties, such as texture. The use of these images to automatically map soil texture is,

however, complicated by the presence of vegetation cover, which can mask the soil spectral response. A multistep methodology based on the use of ground, satellite and ancillary data is proposed and tested to map soil texture in Grosseto, a province of Central Italy. The methodology first separated vegetated and nonvegetated pixels of Landsat Thematic Mapper (TM) images by the use of an appropriate spectral index, the Soil Adjusted Vegetation Index (SAVI). Next, different transforms (nonparametric and parametric) were tuned using ground samples and applied to the two pixel types to separately extract relevant spectral information. The outcomes of these transforms were then merged and subjected to further processing aimed at reducing noise and conveying spatial information to the mapping process. The stratification of the soil texture estimates obtained on different lithological units was finally tested to further improve map accuracy.

Document Type: Article

Source: Scopus

Ekercin, S.^a , Ormeci, C.^b

Estimating soil salinity using satellite remote sensing data and real-time field sampling

(2008) *Environmental Engineering Science*, 25 (7), pp. 981-988.

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Abstract

This paper presents a new algorithm for estimating the salinity level of soil by using satellite remote sensing data. The study includes a real-time field work performed during the overpass of Landsat-5 satellite on 20/06/2006 over Salt Lake, Turkey. Electrical conductivity (EC) is used as indicator of salinity for developing algorithm by using multiple regression technique. In the image processing step, geometric and radiometric correction procedures are conducted to make satellite remote sensing data comparable with the spectral ground measurements carried out using field spectroradiometer supported by hand-held GPS. Results show that realtime ground and satellite remote sensing data are in good agreement with correlation coefficient values of between 0.92 and 0.97. The developed algorithm gives acceptable and meaningful results with a determination coefficient value of 0.95. Finally, the model is tested at a number of individual sample points, and the test results indicate the validation of the developed model with a R2 value of 0.75. © Mary Ann Liebert, Inc. 2008.

Author Keywords

Electrical conductivity (EC); Landsat-5; Radiometric correction; Satellite remote sensing; Soil salinity

Document Type: Article

Source: Scopus

Soe, M.^a , Won-In, K.^b , Takashima, I.^c , Charusiri, P.^d

Lateritic soil mapping of the Phrae basin, northern Thailand using satellite data

(2008) *ScienceAsia*, 34 (3), pp. 306-316.

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Abstract

Landsat 7 Enhanced Thematic Mapper Plus image data was used to identify and map lateritic soil zones in the Phrae basin which is one of the largest intermountain basins in northern Thailand. The lateritic soil zones were discriminated using band ratio and principal component analysis. The lateritic soil detection images were processed by band ratio (band 3 / band 1), principal component analysis of bands 1 and 3, and principal component analysis of bands 1, 3, 4, and 5. The results of these three indices were superimposed using GIS to define a preliminary lateritic soil image of the study area. A threshold method was used for converting a grey scale image into a binary image. Different threshold values were used to find the most probable areas of lateritic soil zones in the image. The threshold values were determined from a published geological map and known lateritic soil areas with good exposure in the image. The quality of the results was evaluated by the normalized difference vegetation index. Field investigation was carried out to substantiate the remote sensing investigation and the laboratory GIS analysis. This method can also be applied to other lateritic soil and iron oxide regions.

Author Keywords

Band ratio; Lateritic soil mapping; Normalized difference vegetation index; Principal component analysis; Remote sensing; Thresholding

Document Type: Article

Source: Scopus

Sumfleth, K., Duttmann, R.

Prediction of soil property distribution in paddy soil landscapes using terrain data and satellite information as indicators

(2008) *Ecological Indicators*, 8 (5), pp. 485-501. Cited 2 times.

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Abstract

Sustainable land management and land use planning require reliable information about the spatial distribution of the physical and chemical soil properties affecting both landscape processes and services. Although many studies have been conducted to identify the spatial patterns of soil property distribution on various scales and in various landscapes, only little is known about the relationships underlying the spatial distribution of soil properties in intensively used, finely structured paddy soil landscapes in the southeastern part of China. In order to provide adequate soil information for the modelling of landscape processes, such as soil water movement, nutrient leaching, soil erosion and plant growth, this study investigates to what extent cheap and readily available ancillary information derived from digital elevation models and remote sensing data can be used to support soil

mapping and to indicate soil characteristics on the landscape scale. This article focuses on the spatial prediction of the total carbon and nitrogen content and of physical soil properties such as topsoil silt, sand and clay content, topsoil depth and plough pan thickness. Correlation analyses indicate that, on the one side, the distribution of C, N and silt contents is quite closely related to the NDVI of vegetated surfaces and that, on the other side, it corresponds significantly to terrain attributes such as relative elevation, elevation above nearest drainage channel and topographical wetness index. Geostatistical analyses furthermore reflect a moderately structured spatial correlation of these soil variables. The combined use of the above mentioned terrain variables and the NDVI in a multiple linear regression accounted for 29% (silt) to 41% (total C) of the variance of these soil properties. In order to select the best prediction method to accurately map soil property distribution, we compared the performance of different regionalization techniques, such as multi-linear regression, simple kriging, inverse distance to a power, ordinary kriging and regression kriging. Except for the prediction of topsoil clay content, in all cases regression kriging model "C" performed best. Compared to simple kriging, the spatial prediction was improved by up to 14% (total C), 13% (total N) and 10% (silt). Since the autocorrelation lengths of these spatially well correlated soil variables range between three and five times the soil sampling density, we consider regression kriging model "C" to be a suitable method for reducing the soil sampling density. It should help to save time and costs when doing soil mapping on the landscape scale, even in intensively used paddy soil landscapes. © 2007 Elsevier Ltd. All rights reserved.

Author Keywords

Paddy soil landscape; Predictive soil mapping;
Regionalization; Regression kriging; Soil property

distribution

Document Type: Article

Source: Scopus

Friesen, J.^a, Rodgers, C.^{b c}, Ogunrunde, P.G.^d, Hendrickx, J.M.H.^e, Van De Giesen, N.^a

Hydrotope-based protocol to determine average soil moisture over large areas for satellite calibration and validation with results from an observation campaign in the Volta Basin, West Africa

(2008) *IEEE Transactions on Geoscience and Remote Sensing*, 46 (7), art. no. 4524261, pp. 1995-2004.

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Abstract

In West Africa, which is an extremely moisture-limited region, soil water information plays a vital role in hydrologic and meteorologic modeling for improved water resource planning and food security. Recent and upcoming satellite missions, such as SMOS and MetOp, hold promise for the regional

observation of soil moisture. The resolution of the satellites is relatively coarse ($> 100 \text{ km}^2$), which brings with it the need for large-scale soil moisture information for calibration and validation purposes. We put forward a soil moisture sampling protocol based on hydrotopes. Hydrotopes are defined as landscape units that show internally consistent hydrologic behavior. This hydrotope analysis helps in the following ways: 1) by ensuring statistically reliable validation via the reduction of the overall pixel variance and 2) by improving sampling schemes for ground truthing by reducing the chance of sampling bias. As a sample application, we present data from three locations with different moisture regimes within the Volta Basin during both dry and wet periods. Results show that different levels of reduction in the overall pixel variance of soil moisture are obtained, depending on the general moisture status. With respect to the distinction between the different hydrotope units, it is shown that under intermediate moisture conditions, the distinction between the different hydrotope units is highest, whereas extremely dry or wet conditions tend to have a homogenizing effect on the spatial soil moisture distribution. This paper confirms that well-defined hydrotope units yield an improvement at pixel-scale soil moisture averages that can easily be applied. © 2008 IEEE.

Author Keywords

Geostatistics; Hydrotopes; MetOP; Satellites; Scaling; Soil moisture; Soil Moisture and Ocean Salinity (SMOS); West Africa

Document Type: Article

Source: Scopus

Vaudour, E.

Remote sensing of Red Mediterranean soils: A case study in the viticultural southern Rhone Valley using SPOT satellite imagery

(2008) *Geocarto International*, 23 (3), pp. 197-216.

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Grignon, Thiverval-Grignon, France

Abstract

The aim of this work was to map Red Mediterranean soils, for which no previous mapping approach exists, using optical multispectral satellite remote sensing data. This case study explores the use of SPOT XS images over the viticultural Southern Rhone Valley, France, to map exposed vineyard soils. Field spectral measurements were used to distinguish Red Mediterranean soil surfaces during Spring 1999. A supervised maximum likelihood classification was applied to sparsely vegetated and unvegetated surfaces of two spring images from 1995 and 1997, drawing on the field training set and available soil data. Similar global spatial segmentation was obtained despite different soil surface states on these dates. Classification performances were higher than 84% in both images. Mean classification accuracies of Red Mediterranean soils at seven reference surfaces were 60% in 1995 and 70% in 1997. This suggests that the direct use of optical remote sensing data at medium resolution can be useful for mapping bare Red Mediterranean soils.

Author Keywords

Red Mediterranean soils; Remote sensing; SPOT; Vineyards

Document Type: Article

Source: Scopus

Weng, Y.^a, Gong, P.^{b c}, Zhu, Z.^d

Soil salt content estimation in the yellow river delta with satellite hyperspectral data

(2008) *Canadian Journal of Remote Sensing*, 34 (3), pp. 259-270.

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Abstract

Soil salinization is one of the most common land degradation processes and is a severe environmental hazard. The primary objective of this study is to investigate the potential of predicting salt content in soils with hyperspectral data acquired with EO-1 Hyperion. Both partial least-squares regression (PLSR) and conventional multiple linear regression (MLR), such as stepwise regression (SWR), were tested as the prediction model. PLSR is commonly used to overcome the problem caused by high-dimensional and correlated predictors. Chemical analysis of 95 samples collected from the top layer of soils in the Yellow River delta area shows that salt content was high on average, and the dominant chemicals in the saline soil were NaCl and MgCl₂. Multivariate

models were established between soil contents and hyperspectral data. Our results indicate that the PLSR technique with laboratory spectral data has a strong prediction capacity. Spectral bands at 1487-1527, 1971-1991, 2032-2092, and 2163-2355 nm possessed large absolute values of regression coefficients, with the largest coefficient at 2203 nm. We obtained a root mean squared error (RMSE) for calibration (with 61 samples) of RMSEC = 0.753 (R^2 = 0.893) and a root mean squared error for validation (with 30 samples) of RMSEV = 0.574. The prediction model was applied on a pixel-by-pixel basis to a Hyperion reflectance image to yield a quantitative surface distribution map of soil salt content. The result was validated successfully from 38 sampling points. We obtained an RMSE estimate of 1.037 (R^2 = 0.784) for the soil salt content map derived by the PLSR model. The salinity map derived from the SWR model shows that the predicted value is higher than the true value. These results demonstrate that the PLSR method is a more suitable technique than stepwise regression for quantitative estimation of soil salt content in a large area. © 2008 CASI.

Document Type: Article

Source: Scopus

Das, N.N.^{a c}, Mohanty, B.P.^{a c}, Njoku, E.G.^{b d}

A Markov chain Monte Carlo algorithm for upscaled soil-vegetation- atmosphere-transfer modeling to evaluate satellite-based soil moisture measurements

(2008) *Water Resources Research*, 44 (5), art. no. W05416, . Cited 1 time.

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Abstract

A Markov chain Monte Carlo (MCMC) based algorithm was developed to derive upscaled land surface parameters for a soil-vegetation-atmosphere-transfer (SVAT) model using time series data of satellite-measured atmospheric forcings (e.g., precipitation), and land surface states (e.g., soil moisture and vegetation). This study focuses especially on the evaluation of soil moisture measurements of the Aqua satellite based Advanced Microwave Scanning Radiometer (AMSR-E) instrument using the new MCMC-based scaling algorithm. Soil moisture evolution was modeled at a spatial scale comparable to the AMSR-E soil moisture product, with the hypothesis that the characterization of soil microwave emissions and their variations with space and time on soil surface within the AMSR-E footprint can be represented by an ensemble of upscaled soil hydraulic parameters. We demonstrated the features of the MCMC-based parameter upscaling algorithm (from field to satellite footprint scale) within a SVAT model framework to evaluate the satellite-based brightness temperature/soil moisture measurements for different hydroclimatic regions, and identified the temporal effects of vegetation (leaf area index) and other environmental factors on AMSR-E based remotely sensed soil moisture data. The SVAT modeling applied for different hydroclimatic regions

revealed the limitation of AMSR-E measurements in high-vegetation regions. The study also suggests that inclusion of soil moisture evolution from the proposed upscaled SVAT model with AMSR-E measurements in data assimilation routine will improve the quality of soil moisture assessment in a footprint scale. The technique also has the potential to derive upscaled parameters of other geophysical properties used in remote sensing of land surface states. The developed MCMC algorithm with SVAT model can be very useful for land-atmosphere interaction studies and further understanding of the physical controls responsible for soil moisture dynamics at different scales. Copyright 2008 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Li, Z.-A.^{a c}, Zhang, X.^{a b}, Tang, B.^{a b}, Jia, Y.-Y.^{a b}

Estimation of bare surface soil moisture using geostationary satellite data

(2008) *International Geoscience and Remote Sensing Symposium (IGARSS)*, art. no. 4423204, pp. 1931-1934.

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Abstract

Surface soil moisture is a key variable in computing several important variables of the land energy and water budget

(albedo, hydraulic conductivity etc). At the same time, surface soil moisture affects the diurnal change of surface temperature. Meteorological satellite data have great potential for providing estimation of surface soil moisture with high temporal resolution on a daily basis. This paper compares some relationship between the parameters derived by fitting Land Surface Temperature (LST) with its diurnal cycle model and surface soil moisture, The results showed that lag time (the difference of the time corresponding to maximum surface temperature and that to maximum solar net short-wave radiation) is most correlated to surface soil moisture. © 2007 IEEE.

Author Keywords

Diurnal land surface temperature; Geostationary satellite data; Lag time; MSG; Surface soil moisture

Document Type: Conference Paper

Source: Scopus

Chang, T.-Y.^a, Liou, Y.-A.^b

Using microwave satellite data to study the spatial soil moisture changes on the Tibetan Plateau

(2008) *International Geoscience and Remote Sensing Symposium (IGARSS)*, art. no. 4423191, pp. 1881-1884.

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Abstract

The microwave remote sensing has long been considered as

an important technique to determine and quantify the state and amount of soil moisture. With the improved knowledge of land-air interaction and the advance of sensor technology, using microwave remote sensing to estimate the soil moisture has achieved a practical level. In this paper, we compare and evaluate four soil moisture retrieval algorithms developed by Jackson [1], Liou et al. [2], Macelloni et al. [3] and Paloscia et al. [4]. Data used to analyze the performance of these retrieval algorithms includes TRMM-TMI data acquired in 1998 and 2001, and AMSR-E data taken in July 2006. The result indicates that the soil moisture retrieval algorithm developed by Liou et al. [2] has better correlation and less bias as compared with the in situ measurement. The Liou model is further applied to study the spatial variability of the soil moisture in the Tibetan Plateau and has achieved a promising result. In future, we attempt to further refine the Liou model for global soil moisture study. © 2007 IEEE.

Author Keywords

Microwave remote sensing; Soil moisture; Tibetan plateau

Document Type: Conference Paper

Source: Scopus

Jones, A.S.^a , Combs, C.L.^a , Lakhankar, T.^a , Longmore, S.^a , Haar, T.H.V.^a , McWilliams, G.^b , Mungiole, M.^b , Mason, G.^c

NPOESS soil moisture satellite data assimilation:

Progress using WindSat data

(2008) *International Geoscience and Remote Sensing Symposium (IGARSS)*, art. no. 4423016, pp. 1185-1187.

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^c Engineer Research and Development Center (ERDC), Army Corp of Engineers, Vicksburg, MS, United States

Abstract

In this work, we have developed a four-dimensional coupled atmospheric/land data assimilation framework using the Regional Atmospheric Modeling Data Assimilation System (RAMDAS) to retrieve deep soil moisture profiles. Passive microwave data from CORIOLIS WindSat are used as a surrogate for future National Polar-orbiting Operational Environmental Satellite System (NPOESS) microwave sensors. Current efforts are focused on the use of the system for a case study occurring in September 2003. © 2007 IEEE.

Author Keywords

Data assimilation; Passive microwave; Soil moisture

Document Type: Conference Paper

Source: Scopus

Pellarin, T.^a , Ali, A.^b , Chopin, F.^c , Jobard, I.^c , Bergès, J.-C.^d

Using spaceborne surface soil moisture to constrain satellite precipitation estimates over West Africa

(2008) *Geophysical Research Letters*, 35 (2), art. no. L02813, .

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Abstract

This paper describes a methodology to use the passive microwave measurements of the 6.9 GHz bandwidth of the AMSR-E sensor which is the most sensitive to surface soil moisture, to constrain satellite-based rainfall estimates over a semi arid region in West-Africa. The paper focuses on the aptitude of AMSR-E measurements to inform if rain occurs or not. The study was conducted over a 125×100 km² region located in Niger where a dense recording raingauge network is available to build an accurate ground-based 3-hour rainfall product at the 25×20 km² resolution. A satellite-based rainfall product (EPSAT-SG), based on both infrared and microwave measurements, was compared to the ground-based rainfall product. It was shown that EPSAT-SG overestimates by about 30% the total number of rain events during the 2004 and 2006 rainy seasons. A simple methodology based on the AMSR-E polarization ratio variations related to the surface soil moisture led to suppress a large amount of the wrong rain events. Copyright 2008 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Vrieling, A.^a , de Jong, S.M.^b , Sterk, G.^c , Rodrigues, S.C.^d

Timing of erosion and satellite data: A multi-resolution approach to soil erosion risk mapping

International Journal of Applied Earth Observations and Geoinformation, . Article in Press.

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Abstract

Erosion reduces soil productivity and causes negative downstream impacts. Erosion processes occur on areas with erodible soils and sloping terrain when high-intensity rainfall coincides with limited vegetation cover. Timing of erosion events has implications on the selection of satellite imagery, used to describe spatial patterns of protective vegetation cover. This study proposes a method for erosion risk mapping with multi-temporal and multi-resolution satellite data. The specific objectives of the study are: (1) to determine when during the year erosion risk is highest using coarse-resolution data, and (2) to assess the optimal timing of available medium-resolution images to spatially represent vegetation cover during the high erosion risk period. Analyses were performed for a 100-km² pasture area in the Brazilian Cerrados. The first objective was studied by qualitatively comparing three-hourly TRMM rainfall estimates with MODIS NDVI time series for one full year (August 2002-August

2003). November and December were identified as the months with highest erosion risk. The second objective was examined with a time series of six available ASTER images acquired in the same year. Persistent cloud cover limited image acquisition during high erosion risk periods. For each ASTER image the NDVI was calculated and classified into five equally sized classes. Low NDVI was related to high erosion risk and vice versa. A DEM was used to set approximately flat zones to very low erosion risk. The six resulting risk maps were compared with erosion features, visually interpreted from a fine-resolution QuickBird image. Results from the October ASTER image gave highest accuracy (84%), showing that erosion risk mapping in the Brazilian Cerrados can best be performed with images acquired shortly before the first erosion events. The presented approach that uses coarse-resolution temporal data for determining erosion periods and medium-resolution data for effective erosion risk mapping is fast and straightforward. It shows good potential for successful application in other areas with high spatial and temporal variability of vegetation cover. © 2007 Elsevier B.V. All rights reserved.

Author Keywords

Brazilian cerrados; Multi-resolution; Multi-temporal; Risk assessment; Soil erosion; Validation; Vegetation

Document Type: Article in Press

Source: Scopus

Osińska-Skotak, K.

Studies of soil temperature on the basis of satellite data

(2007) *International Agrophysics*, 21 (3), pp. 275-284.

Faculty of Geodesy and Cartography, Warsaw University of Technology, Pl. Politechniki 1, 00-661 Warsaw, Poland

Abstract

Thermal properties of soils can be investigated from satellite level, using a number of satellite systems (a.o. LANDSAT ETM+, ASTER/TERRA). Studies conducted in this work were aimed at searching for relationships between brightness temperature of soil surface layer - derived from satellite images - and various properties of soil (type of soil, class of agricultural suitability, texture of top layer of soil, land use). As a result of the analysis it was found that mainly the class of agricultural suitability and the type of soil have an important influence on brightness temperature of soil surface layer. Lower correlations with brightness temperature were observed in the case of texture of surface and under-surface layers of soil. © 2007 Institute of Agrophysics, Polish Academy of Sciences.

Author Keywords

Brightness temperature; Remote sensing; Satellite image; Thermal image

Document Type: Article

Source: Scopus

Schmugge, T.^a, Ogawa, K.^b, De Rosnay, P.^c

Satellite observations of the land surface emissivity in the 8-12 μm window: Effect of soil moisture
(2007) *IAHS-AISH Publication*, (316), pp. 16-21.

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Toulouse, France

Abstract

Monthly and 8-day composites of thermal infrared (TIR) surface emissivity data from the MODerate resolution Imaging Spectrometer (MODIS) sensor on NASA's Terra satellite were analysed for temporal variations over North Africa. It was found that the emissivity of the 8.55 μm band (MODIS band 29) increased by about 0.1 each July/August in the southwestern Sahara (19° N , 3° W). To understand this increase, the emissivity variation was compared with the normalized difference vegetation index (NDVI) also derived from MODIS, with soil moisture estimates from the Advanced Microwave Scanning Radiometer (AMSR-E) microwave sensor on NASA's Aqua satellite and with ground measures of soil moisture. No correspondence was found with NDVI in this area. However, the TIR emissivity increase was found to be qualitatively correlated with an increase in the AMSR derived soil moisture. This increase in TIR emissivity with soil moisture is in agreement with the laboratory measurements. Copyright © 2007 IAHS Press.

Author Keywords

AMSR; Emissivity; Mali; MODIS; Soil moisture; Thermal infrared

Document Type: Conference Paper

Source: Scopus

Wang, L., Qu, J.J.

NMDI: A normalized multi-band drought index for monitoring soil and vegetation moisture with satellite

remote sensing

(2007) *Geophysical Research Letters*, 34 (20), art. no. L20405, . Cited 1 time.

EastFIRE Laboratory, Department of Earth System and Geoinformation Sciences, George Mason University, 4400 University Drive, Fairfax, VA 22030, United States

Abstract

A new index, the Normalized Multi-band Drought Index (NMDI), is proposed for monitoring soil and vegetation moisture from space. NMDI is defined as $NMDI = \frac{R_{860nm} - (R_{1640nm} - R_{2130nm})}{R_{860nm} + (R_{1640nm} - R_{2130nm})}$, where R represents the apparent reflectance observed by a satellite sensor. Similar to the Normalized Difference Water Index, NMDI uses the 860 nm channel as the reference; instead of using a single liquid water absorption channel, however, it uses the difference between two liquid water absorption channels centered at 1640 nm and 2130 nm as the soil and vegetation moisture sensitive band. Analysis revealed that by combining information from multiple near infrared, and short wave infrared channels, NMDI has enhanced the sensitivity to drought severity, and is well suited to estimate both soil and vegetation moisture. Typical soil reflectance spectra and satellite-acquired reflectances, are used to validate the usefulness of NMDI. Its application to areas with moderate vegetation coverage, however, needs further investigation. Copyright 2007 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Liu, Y.^{a b}, de Jeu, R.A.M.^a, van Dijk, A.I.J.M.^b, Owe, M.^c
TRMM-TMI satellite observed soil moisture and vegetation density (1998-2005) show strong connection with El Niño in eastern Australia
(2007) *Geophysical Research Letters*, 34 (15), art. no. L15401, . Cited 3 times.

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^b Commonwealth Scientific and Industrial Research Organization, Division of Land and Water, Black Mountain Laboratory, G.P.O. Box 1666, Canberra, ACT 2601, Australia

^c Hydrological Sciences Branch, NASA Goddard Space Flight Center, Mail Code 614.3, Greenbelt, MD 20771, United States

Abstract

Spatiotemporal patterns in soil moisture and vegetation water content across mainland Australia were investigated from 1998 through 2005, using TRMM/TMI passive microwave observations. The Empirical Orthogonal Function technique was used to extract dominant spatial and temporal patterns in retrieved estimates of moisture content for the top 1-cm of soil (θ) and vegetation moisture content (via optical depth τ). The dominant temporal θ and τ patterns were strongly correlated to the El Niño Southern Oscillation Index (SOI) in spring ($\tau_2 = 0.90$), and to a progressively lesser extent autumn, summer and winter. The Indian Ocean Dipole (IOD) index also explained part of the variation in spring θ and τ . Correlation analysis suggested that the regions most affected by El Niño are mainly located in eastern Australia. The results suggest that the drought conditions experienced in eastern

Australia since 2000 and clearly expressed in these satellite observations have a strong connection with El Niño.

Document Type: Article

Source: Scopus

Carlson, T.

An overview of the "triangle method" for estimating surface evapotranspiration and soil moisture from satellite imagery

(2007) *Sensors*, 7 (8), pp. 1612-1629. Cited 10 times.

Department of Meteorology, PennState University, 619 Walker Building, University Park, PA 16802

Abstract

An overview of the 'triangle' method for estimating soil surface wetness and evapotranspiration fraction from satellite imagery is presented here. The method is insensitive to initial atmospheric and surface conditions, net radiation and atmospheric correction, yet can yield accuracies comparable to other methods. We describe the method first from the standpoint of the how the triangle is observed as obtained from aircraft and satellite image data and then show how the triangle can be created from a land surface model. By superimposing the model triangle over the observed one, pixel values from the image are determined for all points within the triangle. We further show how the stretched (or 'universal') triangle can be used to interpret pixel configurations within the triangle, showing how the temporal trajectories of points uniquely describe patterns of land use change. Finally, we conclude the paper with a brief assessment of the method's limitations. © 2007 by MDPI.

Author Keywords

Evapotranspiration; Land use analysis; Surface wetness;
Triangle method

Document Type: Review

Source: Scopus

Jones, L.A.^{a b c}, Kimball, J.S.^d, McDonald, K.C.^{a e}, Chan, S.T.K.^{a e}, Njoku, E.G.^{a e}, Oechel, W.C.^f

Satellite microwave remote sensing of boreal and arctic soil temperatures from AMSR-E

(2007) *IEEE Transactions on Geoscience and Remote Sensing*, 45 (7), pp. 2004-2018. Cited 1 time.

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^f Global Change Research Group, San Diego State University, San Diego, CA 92182, United States

Abstract

Methods are developed and evaluated to retrieve surface soil temperature information for the Advanced Microwave

Scanning Radiometer on Earth Observing System for seven boreal forest and Arctic tundra biophysical monitoring sites across Alaska and Northern Canada. A multiple-band iterative radiative transfer process-based method producing dynamic vegetation and snow cover correction quantities and an empirical multiple regression method using several frequencies are employed. The seasonal pattern of microwave emission and relative accuracy of the soil temperature retrievals are influenced strongly by landscape properties, including the presence of open water, vegetation type and seasonal phenology, snow cover, and freeze-thaw transitions. The retrieval of soil temperature is similar for the two methods with an overall root-mean-square error of 3.1-3.9 K during summer thawed conditions, with a larger error occurring in winter during periods of dynamic snow cover and freeze-thaw state. These results indicate that at high latitudes, the influence of the atmosphere may be less important than that of surface conditions in determining the relative accuracy of the estimated soil temperature. Impacts of surface conditions on surface emissivity, observed brightness temperature, and estimated soil temperature are discussed. © 2007 IEEE.

Author Keywords

Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E); Arctic tundra; Boreal forest; Microwave radiometry; Satellite remote sensing; Soil temperature

Document Type: Conference Paper

Source: Scopus

Tischler, M.^a , Garcia, M.^b , Peters-Lidard, C.^c , Moran, M.S.^d ,

Miller, S.^e , Thoma, D.^d , Kumar, S.^b , Geiger, J.^c

A GIS framework for surface-layer soil moisture estimation combining satellite radar measurements and land surface modeling with soil physical property estimation

(2007) *Environmental Modelling and Software*, 22 (6), pp. 891-898. Cited 6 times.

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^b University of Maryland - Baltimore County, NASA Goddard Space Flight Center, Code 614.3, Greenbelt, MD 20771, United States

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^e Department of Renewable Resources, University of Wyoming, 1000 E. University Dr, Laramie, WY 82071, United States

Abstract

A GIS framework, the Army Remote Moisture System (ARMS), has been developed to link the Land Information System (LIS), a high performance land surface modeling and data assimilation system, with remotely sensed measurements of soil moisture to provide a high resolution estimation of soil moisture in the near surface. ARMS uses available soil (soil texture, porosity, Ksat), land cover (vegetation type, LAI, Fraction of Greenness), and atmospheric data (Albedo) in standardized vector and raster

GIS data formats at multiple scales, in addition to climatological forcing data and precipitation. PEST (Parameter ESTimation Tool) was integrated into the process to optimize soil porosity and saturated hydraulic conductivity (Ksat), using the remotely sensed measurements, in order to provide a more accurate estimate of the soil moisture. The modeling process is controlled by the user through a graphical interface developed as part of the ArcMap component of ESRI ArcGIS.

Author Keywords

ARMS; GIS; Land Information System; Model integration; Parameter estimation; Soil moisture

Document Type: Article

Source: Scopus

Martyniak, L.^a , Dabrowska-Zielinska, K.^b , Szymczyk, R.^c , Gruszczynska, M.^b

Validation of satellite-derived soil-vegetation indices for prognosis of spring cereals yield reduction under drought conditions - Case study from central-western Poland

(2007) *Advances in Space Research*, 39 (1), pp. 67-72. Cited 1 time.

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^b Institute of Geodesy and Cartography, Modzelewskiego 27, 02-679 Warsaw, Poland

^c The Research Centre for Testing Cultivars, Słupia W., Poland

Abstract

The applicability of satellite-derived indices (NDVI) for drought forecasting in reference to spring cereals production in central-western Poland has been analysed. The study was based on field experiment results of spring cereals yield, phenological observations and meteorological data at four agricultural experimental stations from the period 1992-2002. Based on the collected data, the precipitation deficit in relation to water demand in various phenological phases of crop development was calculated. The crop water demand was calculated as ET_{crop} for 10 day-step using a computer model FAO CROPWAT. The precipitation deficit and cereal grain yield reduction and NDVI in the particular period of crop growth were analysed. The relationship between evapotranspiration (ET_{crop}) and NDVI for all spring cereals was weak, but much stronger for particular spring cereals. The statistically significant relationships were found between soil moisture in the root zone and soil moisture index (SMI) derived from satellite and meteorological data. Our results suggest that NDVI index was not sufficient for drought forecasting and should be supported by additional data from meteorological stations, such as temperature or the amount of solar radiation. © 2006 COSPAR.

Author Keywords

Cereals; Drought; Evapotranspiration; NDVI; Soil moisture index; Yield

Document Type: Article**Source:** Scopus

Drusch, M.

Initializing numerical weather prediction models with satellite-derived surface soil moisture: Data assimilation experiments with ECMWF's integrated

forecast system and the TMI soil moisture data set

(2007) *Journal of Geophysical Research D:*

Atmospheres, 112 (3), art. no. D03102, . Cited 11 times.

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Reading RG2 9AX, United Kingdom

Abstract

Satellite-derived surface soil moisture data sets are readily available and have been used successfully in hydrological applications. In many operational numerical weather prediction systems the initial soil moisture conditions are analyzed from the modeled background and 2 m temperature and relative humidity. This approach has proven its efficiency to improve surface latent and sensible heat fluxes and consequently the forecast on large geographical domains. However, since soil moisture is not always related to screen level variables, model errors and uncertainties in the forcing data can accumulate in root zone soil moisture. Remotely sensed surface soil moisture is directly linked to the model's uppermost soil layer and therefore is a stronger constraint for the soil moisture analysis. For this study, three data assimilation experiments with the Integrated Forecast System (IFS) of the European Centre for Medium-Range Weather Forecasts (ECMWF) have been performed for the 2-month period of June and July 2002: a control run based on the operational soil moisture analysis, an open loop run with freely evolving soil moisture, and an experimental run incorporating TMI (TRMM Microwave Imager) derived soil moisture over the southern United States. In this experimental run the satellite-derived soil moisture product is introduced through a nudging scheme using 6-hourly increments. Apart from the soil moisture analysis, the system setup reflects the operational forecast configuration including the atmospheric 4D-Var analysis. Soil moisture analyzed in

the nudging experiment is the most accurate estimate when compared against in situ observations from the Oklahoma Mesonet. The corresponding forecast for 2 m temperature and relative humidity is almost as accurate as in the control experiment. Furthermore, it is shown that the soil moisture analysis influences local weather parameters including the planetary boundary layer height and cloud coverage.
Copyright 2007 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Mahadevan, P.^a , Koike, T.^a , Fujii, H.^a , Tamagawa, K.^a , Li, X.^b , Kaihotsu, I.^c

Modification and application of the satellite-based land data assimilation scheme for very dry soil regions using AMSR-E images: Model validation for Mongolia - A CEOP data platform

(2007) *Journal of the Meteorological Society of Japan*, 85 A (SPEC. ISS.), pp. 243-260.

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^c Dept. of Civil Engineering, Hiroshima University, Higashi-Hiroshima, Japan

Abstract

At climatic time-scales, soil moisture is one of the most important boundary condition controlling fluxes to the

atmosphere. Here, we explore the feasibility of synthesizing distributed fields of soil moisture using AMSR-E observations and a novel application of data assimilation within a hydrological model. We modified our existing Land Data Assimilation Scheme (LDAS) by specifically considering: (1) weak constraint assumptions rather than a strong constraint, thus accounting for the existence of model errors; and (2) the effects of volume scattering within the soil medium in the Radiative Transfer Model (RTM). Adopting the "effects of volume scattering within the dry soil medium" in the RTM is a new step for satellite-based data assimilation techniques for the retrieval of soil moisture. This LDAS can be used to assess model parameters and estimate vertical profiles of soil moisture, especially in very dry regions (volumetric soil moisture is equal to or less than 5-15%) as well as soil-surface and canopy temperatures by comparing passive microwave observations using a unique minimization technique termed Very Fast Simulated Annealing (VFSA). To validate our new LDAS, AMSR-E observations, gathered in Mongolia, were assimilated into the Land Surface Model (LSM) via the modified RTM. Observed micrometeorology boundary conditions for Mongolia were drawn from the CEOP database. In studies that simulate 2-week dry periods, the results of the revised LDAS are in better agreement with observational data than the results of open-loop simulations. © 2007, Meteorological Society of Japan.

Document Type: Article

Source: Scopus

Wagner, W.^a , Naeimi, V.^a , Scipal, K.^b , Jeu, R.^c , Martínez-Fernández, J.^d

Soil moisture from operational meteorological satellites

(2007) *Hydrogeology Journal*, 15 (1), pp. 121-131. Cited 20 times.

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^b European Centre for Medium-Range Weather Forecasts (ECMWF), Shinfield Park, Reading RG2 9AX, United Kingdom

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^d Department of Geography, University of Salamanca, Salamanca 37002, Spain

Abstract

In recent years, unforeseen advances in monitoring soil moisture from operational satellite platforms have been made, mainly due to improved geophysical retrieval methods. In this study, four recently published soil-moisture datasets are compared with in-situ observations from the REMEDHUS monitoring network located in the semi-arid part of the Duero basin in Spain. The remotely sensed soil-moisture products are retrieved from (1) the Advanced Microwave Scanning Radiometer (AMSR-E), which is a passive microwave sensor on-board NASA's Aqua satellite, (2) European Remote Sensing satellite (ERS) scatterometer, which is an active microwave sensor on-board the two ERS satellites and (3) visible and thermal images from the METEOSAT satellite. Statistical analysis indicates that three satellite datasets contribute effectively to the monitoring of trends in surface soil-moisture conditions, but not to the estimation of absolute soil-moisture values. These sensors, or rather their successors, will be flown on operational meteorological

satellites in the near future. With further improvements in processing techniques, operational meteorological satellites will increasingly deliver high-quality soil-moisture data. This may be of particular interest for hydrogeological studies that investigate long-term processes such as groundwater recharge. © Springer-Verlag 2006.

Author Keywords

Remote sensing; Satellites; Scale effects; Soil moisture; Unsaturated zone

Document Type: Article

Source: Scopus

Philipps, S., Boone, C., Obligis, E.

The role of averaging for improving sea surface salinity retrieval from the Soil Moisture and Ocean Salinity (SMOS) satellite and impact of auxiliary data

(2007) *Journal of Atmospheric and Oceanic*

Technology, 24 (2), pp. 255-269. Cited 1 time.

CLS Space Oceanography Division, 8-10 rue Hermes, 31520 Ramonville St Agne, France

Abstract

Soil Moisture and Ocean Salinity (SMOS) was chosen as the European Space Agency's second Earth Explorer Opportunity mission. One of the objectives is to retrieve sea surface salinity (SSS) from measured brightness temperatures (TBs) at L band with a precision of 0.2 practical salinity units (psu) with averages taken over 200 km by 200 km areas and 10 days [as suggested in the requirements of the Global Ocean Data Assimilation Experiment (GODAE)]. The retrieval is performed here by an inverse model and additional

information of auxiliary SSS, sea surface temperature (SST), and wind speed (W). A sensitivity study is done to observe the influence of the TBs and auxiliary data on the SSS retrieval. The key role of TB and W accuracy on SSS retrieval is verified. Retrieval is then done over the Atlantic for two cases. In case A, auxiliary data are simulated from two model outputs by adding white noise. The more realistic case B uses independent databases for reference and auxiliary ocean parameters. For these cases, the RMS error of retrieved SSS on pixel scale is around 1 psu (1.2 for case B). Averaging over GODAE scales reduces the SSS error by a factor of 12 (4 for case B). The weaker error reduction in case B is most likely due to the correlation of errors in auxiliary data. This study shows that SSS retrieval will be very sensitive to errors on auxiliary data. Specific efforts should be devoted to improving the quality of auxiliary data. © 2007 American Meteorological Society.

Document Type: Article

Source: Scopus

Zhang, X., Chen, J., Tan, M., Sun, Y.

Assessing the impact of urban sprawl on soil resources of Nanjing city using satellite images and digital soil databases

(2007) *Catena*, 69 (1), pp. 16-30. Cited 2 times.

State Key Laboratory of Soil and Sustainable Agriculture
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China

Abstract

The Yangtse delta area is one of the most rapidly developing areas in China. There are mega-cities like Shanghai and

Nanjing and the surrounding urban areas of different sizes including those along the lower reach of the Yangtse river from Shanghai to Nanjing. In combination with their satellite counties and towns, they form one of the most densely distributed urban areas in China. This is a case study conducted in Nanjing city to evaluate the impact of urban sprawl on soil resources using satellite images and digital soil database maps. The extent of the developed land in the study area and the impact of development on soil resources at a scale of 1:200,000 are estimated. The soil types occupied by the urbanization process are determined by overlaying the soil map on the satellite images (Landsat TM) of the study area at different times (1984, 1995, 2000 and 2003). This study uses a geographic information system (GIS) to combine urban land use maps of different times derived from satellite images with data on soil characteristics contained in soil databases. The results document the rapid expansion of urbanization in Nanjing city, as well as the soil types occupied by the urbanization process, and their quality. The urban area has increased 43,544 ha, 2 times more than in 1984. The urban area expanded at an annual rate of 6.9%. Thirty of the total 32 soil types (soil families) within the city were utilized by the urbanization process among which Loamy typic-Fe-leachic-stagnic anthrosol ranked the highest (12,007 ha). The loss of surface land to urban use in Nanjing city has ranged from 4.8% in 1984 to 11.8% in 2003. Soils of the first class (5349 ha) and second class (20,781 ha) were 61.5% of the total occupied soil area. Results for Nanjing show that residential, commercial, and industrial development, known as "urban sprawl," appear to follow soil resources, with the better agricultural soils being the most affected. Several soil types appear to be on the verge of being replaced by urban sprawl. Growing urbanization may threaten food security, soil diversity and sustainability. The extent and geographic distribution of soil quality and the pedodiversity for land

presently under urbanization in the study area may be determined through modeling. © 2006 Elsevier B.V. All rights reserved.

Author Keywords

Nanjing city; Satellite images; Soil databases; Soil quality; Urban sprawl; Yangtse delta

Document Type: Article

Source: Scopus

Bricklemeyer, R.S.^a , Lawrence, R.L.^a , Miller, P.R.^a ,
Battogtokh, N.^b

Monitoring and verifying agricultural practices related to soil carbon sequestration with satellite imagery

(2007) *Agriculture, Ecosystems and Environment*, 118 (1-4), pp. 201-210. Cited 2 times.

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Abstract

The Kyoto Protocol entering into force on 16 February 2005 continues to spur interest in development of carbon trading mechanisms internationally and domestically. Critical to the development of a carbon trading effort is verification that carbon has been sequestered, and field level measurement of C change is likely cost prohibitive. Estimating C change based on agricultural management practices related to carbon

sequestration seems more realistic, and analysis of satellite imagery could be used to monitor and verify these practices over large areas. We examined using Landsat imagery to verify crop rotations and quantify crop residue biomass in north central Montana. Field data were collected using a survey of farms. Standard classification tree analysis (CTA) and boosted classification and regression tree analysis (BCTA) were used to classify crop types. Linear regression (LM), regression tree analysis (RTA), and stochastic gradient boosting (SGB) were used to estimate crop residue. Six crop types were classified with 97% accuracy (BCTA) with class accuracies of 88-99%. Paired t-tests were used to compare the difference between known and predicted mean crop residue biomass. The difference between known and predicted mean residues using SGB was not different than 0 (p-value = 0.99); however root mean square error (RMSE) was large (1981 kg ha⁻¹), implying that SGB accurately predicted regional crop residue biomass but not local predictions (i.e., field or farm level). The results of this study, and previous research classifying tillage practices and estimating soil disturbance, supports using satellite imagery as an effective tool for monitoring and verifying agricultural management practices related to carbon sequestration over large areas.

Author Keywords

Boosting; Carbon sequestration; Classification and regression tree; Crop residue biomass; Crop types; Landsat imagery

Document Type: Article

Source: Scopus

Gouweleeuw, B.^a , Owe, M.^a , Holmes, T.^b

Land surface modeling and satellite passive microwave imagery: A comparison of top soil moisture and surface temperature estimates

(2006) *Proceedings of SPIE - The International Society for Optical Engineering*, 6359, art. no. 635908, .

^a NASA/GSFC, Greenbelt, MD 20771, United States

^b Vrije Universiteit, Amsterdam, Netherlands

Abstract

Improved accuracy in defining initial conditions for fully-coupled numerical weather prediction models (NWP) along with continuous internal bias corrections for baseline data generated by uncoupled Land Surface Models (LSM), is expected to lead to improved short-term to long-range weather forecasting capability. Because land surface parameters are highly integrated states, errors in land surface forcing, model physics and parameterization tend to accumulate in the land surface stores of these models, such as soil moisture and surface temperature. This has a direct effect on the model's water and energy balance calculations, and will eventually result in inaccurate weather predictions. Surface soil moisture and surface temperature estimates obtained with a recently improved retrieval algorithm from the Advanced Microwave Scanner Radiometer (AMSR) aboard NASA's Earth Observing System (EOS) Aqua satellite are evaluated against model output of the Community Noah Land Surface Model operated within the Land Information System (LIS) forced with atmospheric data of the NCEP Global Data Assimilation System (GDAS). The surface temperature retrievals and Noah LSM output are further evaluated against local measurements from the Mesonet observational grid in

Oklahoma. Preliminary analysis presented here shows a potential to improve simulated surface temperature estimates of the Noah model by assimilating satellite derived surface temperature fields. The potential for updating (top) soil moisture seems to be more restricted, mainly as a result of the relatively thick top soil layer of the model as compared to the passive microwave emanation depth.

Author Keywords

Land surface model; Numerical weather prediction; Satellite passive microwave monitoring; Surface soil moisture; Surface temperature

Document Type: Conference Paper

Source: Scopus

Owe, M.^a , De Jeu, R.^b , Holmes, T.^b

Historical data set of satellite - Derived global soil moisture and land surface temperature

(2006) *Proceedings of SPIE - The International Society for Optical Engineering*, 6359, art. no. 63590D, .

^a Hydrological Sciences Branch, NASA GSFC, Greenbelt, MD 20771, United States

^b Dept. of GeoEnvironmental Sciences, Vrije Universiteit Amsterdam, DeBoelelaan 1085, 1081 HV Amsterdam

Abstract

A historical data set of continuous satellite derived global land surface moisture and land surface temperature is being developed jointly by the NASA Goddard Space Flight Center and the Vrije Universiteit Amsterdam. The data will consist of surface soil moisture retrievals from observations of both

historical and currently active satellite microwave sensors, including Nimbus-7 SMMR, DMSP SSM/I, TRMM TMI, and AQUA AMSR-E. The data sets will span the period from November 1978 through December 2005. The soil moisture retrievals are made with the Land Parameter Retrieval Model, which was developed jointly by researchers from the above institutions. The various sensors have some different technical specifications, including primary wavelength, radiometric resolution, and frequency of coverage. Consequently, the soil moisture sensing depth also varies between the different sensors. It is expected that the data will be made available for download by the general science community within about six months. Specifications and capabilities of different sensors and how they affect soil moisture retrievals are discussed.

Author Keywords

Global soil moisture; Land surface modeling; Land surface temperature; Microwave remote sensing; Satellite retrievals

Document Type: Conference Paper

Source: Scopus

Cros, S.^a , Chanzy, A.^a , Calvet, J.-C.^b , Pellarin, T.^c ,
Wigneron, J.-P.^d

Using optical satellite based data to improve soil moisture retrieval from SMOS mission

(2006) *International Geoscience and Remote Sensing Symposium (IGARSS)*, art. no. 4241670, pp. 2021-2024.

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^b Groupe de Météorologie Àmoyenne Échelle Météo-France,

Toulouse, France

^c LTNHE, CNRS, Grenoble, France

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Abstract

SMOS mission will provide micro-wave soil emission data at L-band (1.4 GHz) at global scale with a half-degree spatial resolution. Inversion of model emission permits to retrieve surface soil moisture from SMOS data. These retrievals suffer from a lack of accuracy mainly because of the heterogeneity of land coverage encountered inside a given pixel. The addition of land surface parameters such as vegetation fractions coverage and surface temperature permits to overcome this problem. A feasibility study is presently undertaken with synthetic SMOS data and simulated optical satellite information. The results present significant improvements of soil moisture retrieval accuracy. A future operational scheme including these features will be of relevance for a global surface soil moisture mapping.

Author Keywords

Fcover; Global scale; Inversion; L-band radiometry; Microwave; Modelling; Remote sensing; SMOS; Soil moisture

Document Type: Conference Paper

Source: Scopus

Shi, J.^a, Njoku, E.G.^b, TJackson^c, O'Neill, P.^d

Evaluation of potential error sources for soil moisture retrieval from satellite microwave radiometer

(2006) *International Geoscience and Remote Sensing Symposium (IGARSS)*, art. no. 4241265, pp. 444-446.

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Abstract

This study demonstrates the impacts of land water, dry snow cover, and terrain at sub-pixel scale on soil estimation through numerical simulations. We will demonstrate the quantity of the above different factors contributing to the errors on the soil moisture estimation.

Document Type: Conference Paper

Source: Scopus

Lacava, T.^a , Di Leo, E.V.^a , Pergola, N.^a , Tramutoli, V.^b

Space-time soil wetness variations monitoring by a multi-temporal microwave satellite records analysis

(2006) *Physics and Chemistry of the Earth*, 31 (18), pp. 1274-1283. Cited 2 times.

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Abstract

In the last few years, remote sensing observations have become a useful tool for providing hydrological information, including the quantification of the main physical

characteristics of the catchment, such as topography and land use, and of its variables, like soil moisture or snow cover. Moreover, satellite data have also been largely used in the framework of hydro-meteorological risk mitigation. Recently, an innovative Soil Wetness Variation Index (SWVI) has been proposed, using data acquired by the microwave radiometer AMSU (Advanced Microwave Sounding Unit) which flies aboard NOAA (National Oceanic and Atmospheric Administration) satellites. SWVI is based on a general approach for multi-temporal satellite data analysis (RAT - Robust AVHRR Techniques). This approach exploits the analysis of long-term multi-temporal satellite records in order to obtain a former characterization of the measured signal, in term of expected value and natural variability, providing a further identification of signal anomalies by an automatic, unsupervised change-detection step. Such an approach has already demonstrated, in several studies carried out on extreme flooding events which occurred in Europe in the past few years, its capability in reducing spurious effects generated by natural/observational noise. In this paper, the proposed approach is applied to the analysis of the flooding event which occurred in Europe (primarily in NW Spain) in June 2000. Results obtained, in terms of reliability as well as efficiency in space-time monitoring of soil wetness variation, are presented. Future prospects, in terms of exportability of the methodology on the new dedicated satellite missions, like ESA-SMOS and NASA-HYDROS, are also discussed. © 2006 Elsevier Ltd. All rights reserved.

Author Keywords

AMSU; Flood; Multi-temporal analysis; Satellite passive microwave; Soil wetness

Document Type: Article

Source: Scopus

Jones, A.S.^a , Rapp, D.^a , Combs, C.L.^a , Longmore, S.^a ,
Vukicevic, T.^a , Vonder Haar, T.H.^a , Mason, G.^b , McWilliams,
G.^c , Mungiole, M.^c , Chauhan, N.S.^d

**NPOESS soil moisture satellite data assimilation and
RFI mitigation: Use of windSat data and a discrete
backus-gilbert technique**

(2006) *International Geoscience and Remote Sensing
Symposium (IGARSS)*, art. no. 4241675, pp. 2040-2043.

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Corp of Engineers, Vicksburg, MS, United States

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Abstract

This work develops (1) a four-dimensional data assimilation methodology to retrieve deep soil moisture profiles using the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and other associated data, (2) a methodology for better spatial mapping of the masking effects caused by surface features (i.e., vegetative cover and surface roughness), and (3) a discrete Backus-Gilbert (DBG)-based methodology for reducing the radio frequency interference impacts at 6.7 and 10 GHz.

Author Keywords

Data assimilation; Passive microwave; Soil moisture

Document Type: Conference Paper

Source: Scopus

Jackson, T.J.

Validation of satellite-based soil moisture algorithms

(2006) *Proceedings of SPIE - The International Society for Optical Engineering*, 6301, art. no. 63010D, .

USDA ARS Hydrology and Remote Sensing Laboratory, 104 Bldg., 007 BARC-West, Beltsville, MD 20705

Abstract

Validation is an important but particularly challenging task for passive microwave remote sensing of soil moisture from Earth orbit. The key issue is spatial scale; conventional measurements of soil moisture are made at a point whereas satellite sensors provide an integrated area/volume value for a much larger spatial extent. For microwave remote sensing from space it is necessary to consider the kilometer to 40 km scale, which presents new challenges. This issue of spatial scale is common to both current and future satellite missions. Regardless of the degree of difficulty, ground based sampling must remain a core component of validation. An integrated approach using in situ networks, field campaigns and comparison to other satellite products is described.

Author Keywords

Passive microwave; Soil moisture; Validation

Document Type: Conference Paper

Source: Scopus

Balsamo, G.^{a b} , Mahfouf, J.-F.^a , Bélair, S.^a , Deblonde, G.^a

A global root-zone soil moisture analysis using simulated L-band brightness temperature in preparation for the preparation for the Hydros satellite mission

(2006) *Journal of Hydrometeorology*, 7 (5), pp. 1126-1146. Cited 4 times.

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^b ECMWF, Shinfield Park, Reading, Berkshire RG2 9AX, United Kingdom

Abstract

The aim of this study is to test a land data assimilation prototype for the production of a global daily root-zone soil moisture analysis. This system can assimilate microwave L-band satellite observations such as those from the future Hydros NASA mission. The experiments are considered in the framework of the Interaction Soil Biosphere Atmosphere (ISBA) land surface scheme used operationally at the Meteorological Service of Canada for regional and global weather forecasting. A land surface reference state is obtained after a 1-yr global land surface simulation, forced by near-surface atmospheric fields provided by the Global Soil Wetness Project, second initiative (GSWP-2). A radiative transfer model is applied to simulate the microwave L-band passive emission from the surface. The generated brightness temperature observations are distributed in space and time according to the satellite trajectory specified by the Hydros mission. The impact of uncertainties related to the satellite observations, the land surface, and microwave emission models is investigated. A global daily root-zone soil moisture analysis is produced with a simplified variational scheme. The applicability and performance of the system are evaluated in

a data assimilation cycle in which the L-band simulated observations, generated from a land surface reference state, are assimilated to correct a prescribed initial root-zone soil moisture error. The analysis convergence is satisfactory in both summer and winter cases. In summer, when considering a 3-K observation error, 90% of land surface converges toward the reference state with a soil moisture accuracy better than $0.04 \text{ m}^3 \text{ m}^{-3}$ after a 4-week assimilation cycle. A 5-K observation error introduces 1-week delay in the convergence. A study of the analysis error statistics is performed for understanding the properties of the system. Special features associated with the interactions between soil water and soil ice, and the presence of soil moisture vertical gradients, are examined.

Document Type: Article

Source: Scopus

Makkeasorn, A.^a, Chang, N.-B.^{b e}, Beaman, M.^c, Wyatt, C.^d, Slater, C.^d

Soil moisture estimation in a semiarid watershed using RADARSAT-1 satellite imagery and genetic programming

(2006) *Water Resources Research*, 42 (9), art. no. W09401, . Cited 5 times.

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Abstract

Soil moisture is a critical element in the hydrological cycle especially in a semiarid or arid region. Point measurement to comprehend the soil moisture distribution contiguously in a vast watershed is difficult because the soil moisture patterns might greatly vary temporally and spatially. Space-borne radar imaging satellites have been popular because they have the capability to exhibit all weather observations. Yet the estimation methods of soil moisture based on the active or passive satellite imageries remain uncertain. This study aims at presenting a systematic soil moisture estimation method for the Choke Canyon Reservoir Watershed (CCRW), a semiarid watershed with an area of over 14,200 km² in south Texas. With the aid of five corner reflectors, the RADARSAT-1 Synthetic Aperture Radar (SAR) imageries of the study area acquired in April and September 2004 were processed by both radiometric and geometric calibrations at first. New soil moisture estimation models derived by genetic programming (GP) technique were then developed and applied to support the soil moisture distribution analysis. The GP-based nonlinear function derived in the evolutionary process uniquely links a series of crucial topographic and geographic features. Included in this process are slope, aspect, vegetation cover, and soil permeability to compliment the well-calibrated SAR data. Research indicates that the novel application of GP proved useful for generating a highly nonlinear structure in regression regime, which exhibits very strong correlations statistically between the model estimates

and the ground truth measurements (volumetric water content) on the basis of the unseen data sets. In an effort to produce the soil moisture distributions over seasons, it eventually leads to characterizing local- to regional-scale soil moisture variability and performing the possible estimation of water storages of the terrestrial hydrosphere. Copyright 2006 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Cosh, M.H.^a , Jackson, T.J.^a , Starks, P.^b , Heathman, G.^c

Temporal stability of surface soil moisture in the Little Washita River watershed and its applications in satellite soil moisture product validation

(2006) *Journal of Hydrology*, 323 (1-4), pp. 168-177. Cited 11 times.

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Abstract

The concept of temporal stability can be used to identify persistent soil moisture patterns and estimate the large scale average from select representative sensor locations. Accurate and efficient estimation of large-scale surface soil moisture is a primary component of soil moisture satellite validation

programs. However, monitoring the soil surface at large grid scales is difficult. As part of the aqua satellite advanced microwave scanning radiometer (AMSR) Validation Program, a soil moisture sensor network was installed in the little Washita river watershed in Oklahoma, USA in 2002. Along with data from the soil moisture experiment 2003 (SMEX03), this network will provide a valuable dataset for satellite soil moisture product validation. Analysis shows that most of the network sensors are temporally stable at multiple scales and four sites are identified as representative with negligible bias and small standard deviation to the watershed mean. As part of this analysis, the protocols established for large-scale soil moisture sampling campaigns such as in the soil moisture experiments (SMEX) are validated. This analysis showed that basing grid scale estimates on six sampling points is reasonable and accurate. Temporal stability is shown to be a valuable tool for soil moisture network analysis and can provide an efficient means to large-scale satellite validation. © 2005 Elsevier B.V. All rights reserved.

Author Keywords

Little Washita river watershed; Soil Moisture experiment 2003 (SMEX03); Surface soil moisture; Temporal stability analysis; Time series analysis

Document Type: Article

Source: Scopus

Zhao, D., Su, B., Zhao, M.

Soil moisture retrieval from satellite images and its application to heavy rainfall simulation in eastern China (2006) *Advances in Atmospheric Sciences*, 23 (2), pp. 299-316. Cited 5 times.

Department of Atmospheric Sciences, Nanjing University,
Nanjing 210093, China

Abstract

The soil water index (SWI) from satellite remote sensing and the observational soil moisture from agricultural meteorological stations in eastern China are used to retrieve soil moisture. The analysis of correlation coefficient (CORR), root-mean-square-error (RMSE) and bias (BIAS) shows that the retrieved soil moisture is convincing and close to the observation. The method can overcome the difficulties in soil moisture observation on a large scale and the retrieved soil moisture may reflect the distribution of the real soil moisture objectively. The retrieved soil moisture is used as an initial scheme to replace initial conditions of soil moisture (NCEP) in the model MM5V3 to simulate the heavy rainfall in 1998. Three heavy rainfall processes during 13-14 June, 18-22 June, and 21-26 July 1998 in the Yangtze River valley are analyzed. The first two processes show that the intensity and location of simulated precipitation from SWI are better than those from NCEP and closer to the observed values. The simulated heavy rainfall for 21-26 July shows that the update of soil moisture initial conditions can improve the model's performance. The relationship between soil moisture and rainfall may explain that the stronger rainfall intensity for SWI in the Yangtze River valley is the result of the greater simulated soil moisture from SWI prior to the heavy rainfall date than that from NCEP, and leads to the decline of temperature in the corresponding area in the heavy rainfall days. Detailed analysis of the heavy rainfall on 13-14 June shows that both land-atmosphere interactions and atmospheric circulation were responsible for the heavy rainfall, and it shows how the SWI simulation improves the simulation. The development of mesoscale system plays an important role in the simulation regarding the change of initial

soil moisture for SWI.

Author Keywords

MM5V3; Precipitation; Retrieved volumetric soil moisture;
Soil water index

Document Type: Article

Source: Scopus

Taylor, C.M., Ellis, R.J.

Satellite detection of soil moisture impacts on convection at the mesoscale

(2006) *Geophysical Research Letters*, 33 (3), art. no. L03404, . Cited 7 times.

Centre for Ecology and Hydrology, Crowmarsh Gifford,
Macleans Bldg., Wallingford OX10 8BB, United Kingdom

Abstract

Understanding of interactions between soil moisture and precipitation is limited by a lack of direct observations at spatial scales on which feedbacks occur. This study identifies a sensitivity of convective cloud to spatial variations in soil moisture, based on analysis of satellite observations from many cases in the Sahel. Patches of wet soil were located using passive microwave data. The patches were composited according to length scale, ranging from 37 to 200 km. The response of the convective cloud field to surface variability along the composite cross-section was studied with thermal infra-red data. A suppression of convective cloud is evident over the wet soil during the afternoon and evening for all but the smallest length scales. Analysis of over 100 individual cases where convection occurred in the vicinity of a patch revealed that the development of cloud systems in their early

stages appears to be particularly sensitive to soil moisture.
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Document Type: Article

Source: Scopus

Chen, H.^{a b c}, Xu, X.^a, Liu, Y.^d, Li, Y.^b, Wang, S.^b

Soil moisture prediction based on retrievals from satellite sensings and a regional climate model

(2005) *Proceedings of SPIE - The International Society for Optical Engineering*, 5884, art. no. 58840E, pp. 1-10.

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Abstract

Soil moisture is an ineligible physical variable in agrometeorology, climatology, hydrology, ecology and crop cultivation and predicted normally by use of the Penman formula for meteorological records from a single or a few stations and weather forecasts. This method, however, allows to make the prediction only for a limited number of stations rather than regional gridded predictions. For this reason, we developed a scheme of satellite sensings retrieval, the regional climate model (RegCM2) and a soil water predicting model in combination for moisture in fields of staple crops

over the Huang-Huai Plains, by which to establish a drought warning system, of which 1) the soil water predicting model makes use of the soil moisture balance equation applicable to fields of winter wheat and summer corn in the Plains, whose central component is the Penman formula revised by FAO; 2) the needed NWP products are offered by NCAR RegCM2 and 3) the initial field of soil moisture comes from the retrieval of polar-orbiting meteorological satellite data that are corrected through vegetation cover correction and a variational technique. Results show that the proposed scheme is able to improve the precision of the prediction and to better monitor and predict changes in the moisture and the distribution of drought-hit crop areas over the study plains.

Author Keywords

Prediction; Regional climate model (RegCM2); Remote sensing; Soil moisture; The Huang-Huai Plains

Document Type: Conference Paper

Source: Scopus

Bertram, T.H.^a , Heckel, A.^c , Richter, A.^c , Burrows, J.P.^c ,
Cohen, R.C.^{a b}

Satellite measurements of daily variations in soil NO_x emissions

(2005) *Geophysical Research Letters*, 32 (24), pp. 1-4. Cited 11 times.

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Abstract

Soil Nox emission from agricultural regions in the western United States has been investigated using satellite observations of NO₂ from the SCIAMACHY instrument. We show that the SCIAMACHY observations over a 2 million hectare agricultural region in Montana capture the short intense Nox pulses following fertilizer application and subsequent precipitation and we demonstrate that these variations can be reproduced by tuning the mechanistic parameters in an existing model of soil Nox emissions. Copyright 2005 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Hossain, F.^a, Anagnostou, E.N.^b

Numerical investigation of the impact of uncertainties in satellite rainfall estimation and land surface model parameters on simulation of soil moisture

(2005) *Advances in Water Resources*, 28 (12), pp. 1336-1350. Cited 9 times.

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Abstract

This study aims at evaluating the uncertainty in the prediction of soil moisture (1D, vertical column) from an offline land surface model (LSM) forced by hydro-meteorological and radiation data. We focus on two types of uncertainty: an input error due to satellite rainfall retrieval uncertainty, and, LSM soil-parametric error. The study is facilitated by in situ and remotely sensed data-driven (precipitation, radiation, soil moisture) simulation experiments comprising a LSM and stochastic models for error characterization. The parametric uncertainty is represented by the generalized likelihood uncertainty estimation (GLUE) technique, which models the parameter non-uniqueness against direct observations. Half-hourly infra-red (IR) sensor retrievals were used as satellite rainfall estimates. The IR rain retrieval uncertainty is characterized on the basis of a satellite rainfall error model (SREM). The combined uncertainty (i.e., SREM + GLUE) is compared with the partial assessment of uncertainty. It is found that precipitation (IR) error alone may explain moderate to low proportion of the soil moisture simulation uncertainty, depending on the level of model accuracy - 50-60% for high model accuracy, and 20-30% for low model accuracy. Comparisons on the basis of two different sites also yielded an increase (50-100%) in soil moisture prediction uncertainty for the more vegetated site. This study exemplified the need for detailed investigations of the rainfall retrieval-modeling parameter error interaction within a comprehensive space-time stochastic framework for achieving optimal integration of satellite rain retrievals in land data assimilation systems. © 2005 Elsevier Ltd. All rights reserved.

Author Keywords

Land surface model; Parameter uncertainty; Satellite rain retrievals; Soil moisture; Uncertainty

Document Type: Article

Source: Scopus

Gouweleeuw, B.^a , Franchello, G.^b , Van Der Knijff, J.^b , Owe, M.^a

ERA40 and satellite passive microwave imagery: A comparison of top soil moisture estimates

(2005) *Proceedings of SPIE - The International Society for Optical Engineering*, 5976, art. no. 597609, .

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Abstract

ERA-40 stands for ECMWF Re Analysis and refers to the rerun of the European Centre of Medium Range Weather Forecast (ECMWF) Numerical Weather Prediction (NWP) model for the period September 1957- August 2002 utilizing all state-of-the-art information and satellite data input presently available. From this dataset the top layer volumetric soil water is extracted and evaluated against surface moisture retrievals derived from the SMMR instrument on board the Nimbus-7 satellite for the European window. The evaluation of NWP model output with observed data is relevant to the initialization of land surface conditions in these models, which is important for accurate short term to long range meteorological and hydrological prediction. Because land surface parameters are highly integrated states, errors in land surface forcing, model physics and parameterization tend to accumulate in the land surface stores, such as soil moisture,

of these models This has a direct effect on the model's water and energy balance calculations, and will eventually result in inaccurate weather predictions. It is expected that improved accuracy in defining initial conditions for NWP's along with continuous internal bias corrections for baseline data generated by uncoupled Land Surface Models (LSM), will lead to highly improved short-term to long-range weather forecasting capability. Preliminary analysis presented here reveals the off set between the two data sets, although distinct, is relatively constant, which suggests a potential for improved initialization and bias correction by an optimized accuracy and spatial representation of the soil moisture data fields.

Author Keywords

Numeric weather prediction model initialization; Re-Analysis data; Satellite passive microwave monitoring; Surface soil moisture

Document Type: Conference Paper

Source: Scopus

Prigent, C.^{a g}, Aires, F.^{b c f}, Rossow, W.B.^{d i}, Robock, A.^{e h}

Sensitivity of satellite microwave and infrared observations to soil moisture at a global scale: Relationship of satellite observations to in situ soil moisture measurements

(2005) *Journal of Geophysical Research D: Atmospheres*, 110 (7), art. no. D07110, pp. 1-15. Cited 13 times.

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^c Laboratoire de Météorologie Dynamique, Centre National de la Recherche Scientifique, École Polytechnique, Palaiseau, France

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Abstract

This study presents a systematic and integrated analysis of the sensitivity of the available satellite observations to in situ soil moisture measurements. Although none of these satellites is optimized for land surface characterization, before the launches of the SMOS- and HYDROS-dedicated missions they are the only potential sources of global soil moisture measurements. The satellite observations include passive microwave emissivities, active microwave scatterometer data, and infrared estimates of the diurnal amplitude of the surface

skin temperature. The Global Soil Moisture Data Bank provides in situ soil moisture measurements in five separate regions. This simultaneous analysis of various satellite observations and the large amount of in situ measurements has two major advantages. First, this analysis helps identify and separate the physical mechanisms that affect the satellite observations. For example, we show that the passive microwave polarization differences at 19 GHz and above are essentially sensitive to the vegetation and not to the soil moisture (i.e., the correlation between microwave observations and soil moisture is only indirect and comes from the statistical correlation between vegetation and soil moisture). Second, this analysis enables an objective comparison of the relative potential of the various satellite observations for soil moisture retrieval when other conditions are held constant. The second part of this study benefits from this synthesis to derive a relationship between satellite observations and soil moisture at a global scale. Copyright 2005 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Park, S.^a, Egbert, S.L.^b

Assessment of soil erodibility indices for conservation reserve program lands in Southwestern Kansas using satellite imagery and GIS techniques

(2005) *Environmental Management*, 36 (6), pp. 886-898. Cited 2 times.

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^b Department of Geography, Kansas Applied Remote Sensing

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Abstract

The soil erodibility index (EI) of Conservation Reserve Program (CRP) lands, which was the major criterion for CRP enrollment, was assessed for six counties in southwestern Kansas using USGS seamless digital elevation model data and Geographical Informational System techniques. The proportion of land areas with EI values of 8 or lower was less than 1% of the entire study area and most of the land areas (72.5%) were concentrated on EI values between 8 and 24. Although land acreage with EI values of 24 or higher decreased dramatically, the proportion of CRP lands to the other land-use types did not change much from low to high EI levels. The soil EI and physical soil characteristics of the CRP lands were compared to those of other land-use types. In general, the mean EI values of the land-use types were strongly correlated with physical soil properties, including organic matter content, clay content, available water capacity, permeability, and texture. CRP lands were compared in detail with cropland in terms of their soil characteristics to infer the pivotal cause of the land transformation. Although there was no significant statistical difference in EI between cropland and CRP soils, soil texture, soil family, and permeability were statistically different between the two. Statistical analyses of these three variables showed that CRP soils had coarser texture and higher permeability on average than cropland soils, indicating that CRP lands in the study area are drier than cropland soils. Therefore, soil moisture characteristics, not necessarily soil erosion potential, might have been the key factor for CRP enrollment in the study area. © 2005 Springer Science+Business Media, Inc.

Author Keywords

Conservation Reserve Program; GIS; Soil erodibility index;
Soil properties

Document Type: Article

Source: Scopus

Drunpob, A.^a , Chang, N.B.^a , Beaman, M.^b , Wyatt, C.^c ,
Slater, C.^c

**Seasonal soil moisture variation analysis using
RADARSAT-1 satellite image in a semi-arid coastal
watershed**

(2005) *Proceedings of the Third International Workshop on
the Analysis of Multi-Temporal Remote Sensing Images
2005*, 2005, art. no. 1469869, pp. 186-190.

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Alaska - Fairbanks, Fairbanks, AK

Abstract

This study presents multi-temporal soil moisture using
RADARSAT-1 Synthetic Aperture Radar (SAR) satellite
imagery in Choke Canyon Reservoir Watershed (CCRW). Soil
moisture is a critical element of hydrological cycle that
drastically impacts humans' activities in semi-arid area. Point
measurements of soil moisture across different geographical
landscapes are impossible to comprehend the soil moisture
variations temporally and spatially. RADARSAT-1 is a
promising tool for measuring the surface soil moisture over

seasons with its all-weather capability and the short-period return of its orbiting. Time constraint is almost negligible since the RADARSAT-1 is able to capture surface soil moisture over a large area in a matter of seconds, if the area is within its swath. The CCRW was selected as the study area contributing to the reservoir, which is mostly agricultural and range land in a semi-arid coastal environment, South Texas. RADARSAT-1 images presented at here were captured in three acquisitions in 2004, including April, September and December. Essential radiometric and geometric calibrations of the multi-temporal SAR images were performed to improve the accuracy of information and location, with the aid of five corner reflectors deployed by Alaska Satellite Facility (ASF). The horizontally spatial errors were reduced from initially 560 m down to less than 5 m at the best trial-and-true. Slope data, land cover data, aspect data, and soil type data were incorporated into the regression models, derived from genetic programming algorithm, to predict soil moisture using SAR data. It is necessary to use slope data and aspect data together to represent the effect of the geological slope to the radar backscatter because the slope data only represents the magnitudes of elevation change, while the aspect represents the direction of the slope. The soil moisture estimations show that soil moisture wholly varies in space and season. © 2005 IEEE.

Author Keywords

Component; Ecohydrology; Multi-temporal remote sensing; RADARSAT-1; SAR; Soil moisture

Document Type: Conference Paper

Source: Scopus

Pasqui, M.^{a b e}, Walko, R.L.^c, Migliorini, S.^d, Antonini, A.^{a b}, Melani, S.^{a b}, Messeri, G.^{a b}

Data assimilation scheme of satellite derived heating rates for soil state initialization in a regional atmospheric mesoscale model: Methodology

(2005) *85th AMS Annual Meeting, American Meteorological Society - Combined Preprints*, pp. 3679-3683.

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^c Department of Civil and Environmental Engineering, Duke University, Durham, NC, United States

^d Data Assimilation Research Centre, Department of Meteorology, University of Reading, Reading, United Kingdom

^e CNR, IBIMET, Florence, Italy

Document Type: Conference Paper

Source: Scopus

Lacava, T.^a, Greco, M.^{a b c}, Di Leo, E.V.^a, Martino, G.^b, Pergola, N.^a, Romano, F.^a, Sannazzaro, F.^b, Tramutoli, V.^{a b c}

Assessing the potential of SWVI (Soil Wetness Variation Index) for hydrological risk monitoring by means of satellite microwave observations

(2005) *Advances in Geosciences*, 2, pp. 221-227. Cited 2 times.

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^b Dip. di Ingegneria e Fisica dell'Ambiente, Università della Basilicata, Potenza, Italy

^c CIMA, Università della Basilicata, Università di Genova, Italy

Abstract

In the last years satellite remote sensing applications in hydrology have considerably progressed. A new multi-temporal satellite data-analysis approach has been recently suggested in order to estimate space-time changes of geophysical parameters possibly related to the increase of environmental and hydro-geological hazards. Such an approach has been already used both for flooded area mapping (using AVHRR data) and for soil wetness index estimation (using AMSU data). In this work, a preliminary sensitivity analysis of the proposed Soil Wetness Variation Index (SWVI) is made in the case of low intensity meteorological events by the comparison with hydrological (precipitation) data. This analysis, as a first step of a more complex work in progress, is targeted to a first evaluation of the reliability of the SWVI in describing soil response to precipitations of different duration and intensity.

Document Type: Article

Source: Scopus

Fleming, K., Hendrickx, J.M.H., Hong, S.-H.

Regional mapping of root zone soil moisture using optical satellite imagery

(2005) *Proceedings of SPIE - The International Society for Optical Engineering*, 5811, art. no. 20, pp. 159-170. Cited 5 times.

Dept. Earth and Environ. Sci., New Mexico Tech., 801 Leroy Place, Socorro, NM 87801

Abstract

Root zone soil moisture is a dynamic variable subject to rapid changes in time as well as space. Accurate, detailed information on the distribution of soil moisture is difficult to obtain. Ground based methods for the measurement of temporal and spatial changes in root zone soil moisture require much time and effort and, therefore, have limited value for soil moisture monitoring at the regional scale. Existing remote sensing methods use microwaves to measure soil moisture near the soil surface (0-10 cm). In this study, the Surface Energy Balance Algorithm for Land (SEBAL) is applied to a series of Landsat TM optical images to determine the regional distribution of the evaporative fraction. From this, soil moisture conditions are derived using an empirical relationship between evaporative fraction and root zone soil moisture. Ground measurements available in the Middle Rio Grande Basin do not cover a sufficiently wide range of soil moisture values for validation of the soil moisture maps derived from optical satellite imagery. Therefore, we conducted a qualitative validation by comparing predicted soil moisture conditions along three transects perpendicular to the Rio Grande with ground observations. This analysis shows that the remote sensing approach is successful in distinguishing between moist and dry pixels in the Middle Rio Grande Basin. Further field investigation will be required to validate the product quantitatively.

Document Type: Conference Paper

Source: Scopus

Markle, B.

Global soil moisture mapping: A unified approach for satellite ground processing

(2005) *European Space Agency, (Special Publication) ESA SP, (602), pp. 543-546.*

Array Systems Computing Inc., 1120 Finch Ave. West, North York, Ont. M3J 3H7, Canada

Abstract

In 2010, NASA will launch the \$170M HYDOS satellite to monitor global soil moisture change on nearly a daily basis. The data from HYDROS is expected to produce breakthroughs in our understanding of processes linking the water, energy, and carbon cycles. The accurate measurement of soil moisture has applications ranging from weather prediction and reservoir management, to meteorological nowcasting in support of military mobility and decision making. In this paper we will review a variety of applications that demonstrate the growing need for a software architecture that is scalable and supports rapid prototyping and validation of remote sensing algorithms. In addition, we will discuss why the assimilation of new data sources, as they become available, must be an integral part of this architecture. Array Systems Computing Inc. (Array) has developed a Scalable Generic Signal Processing architecture that has been used to rapidly prototype the HYDROS satellite active radar processing. Array is currently under contract with ESA to develop the SMOS Level 2 Soil Moisture Prototype Processor. Typically, only 14% of available satellite data from operational Earth observing systems are used today. Due to the lack of efficient data assimilation tools, and in order to reduce data management problems, much of the data is simply discarded. Also, current models of the emissivity of snow and sea ice and the effects

of cloud are incomplete and often unusable, which again results in the culling of data. Compounding the problem of the under utilization of the data is the fact that there will be an increase by five-orders of magnitude in the available satellite data from 2000 to 2010 (illustrated in Figure 1 below). This increase in the availability of satellite data, and the requirement to improve models and not discard data, demands the availability of scalable high performance computing systems for future remote sensing applications. In order to take advantage of the synergy between different satellite observation systems, ground processors need to be flexible in order to merge data from new sensors as they come online. For example, there is a synergy between NASA's Hydrosphere States (HYDROS) and ESA's Soil Moisture and Ocean Salinity (SMOS) missions, which can be utilized by merging or fusing these data sources. The combined HYDROS/SMOS measurements sample most of the Earth's surface in 1 to 2 days. By combining the SMOS multi-angle measurements with the HYDROS single-incidence angle measurements, greater precision and calibration stability is achieved. The growing demand for greater accuracy and faster delivery of soil moisture products requires future satellite ground processors to be flexible and scalable, thereby allowing new or revised time series filtering algorithms to be implemented as soon as they become available. For example, a synergy exists between the two HYDROS sensors, which can be used to produce better resolution products through the use of time series filtering. The first HYDROS sensor is a passive L-band microwave coarse resolution radiometer, and the second sensor is an active L-band fine-resolution radar (these two sensors have different spatial resolutions and different errors associated with them). Research is currently being done on the feasibility of generating a median resolution soil moisture product by combining both the radiometer and radar observations with

the use of an Extended Kalman Filter (EKF). The data assimilation of satellite measurements into Numerical Weather Prediction (NWP) models is an area of active research. In operational NWP calculations, the unobserved state of the system is updated when new data becomes available, which can be calculated using covariance recursions ("Estimation of High-dimensional Prior and Posterior Covariance Matrices in Kalman Filter Variants", Furrer and Bengtsson, 2004). Since the dimension of the state vector is typically very high, direct implementation of the covariance recursions is too computationally expensive, and Monte Carlo methods, such as the Ensemble Kalman Filter, have been recently developed in order to reduce the computational burden. An Ensemble Kalman filter (EnKF) proposed for HYDROS uses a Monte-Carlo ensemble of short-range forecasts to estimate the covariances of the forecast error. Ensemble Kalman Smoothing has been proposed for the re-analysis of HYDROS data, and is expected to yield good estimates of volumetric soil moisture at the surface and sub-surface. Combining the higher resolution active L-band observations with the lower resolution, but more accurate passive observations, will provide information on the spatial distribution of soil moisture. Since these NWP algorithms are currently in development, a matter of great practical concern is the transition from a research and development platform into a operational system. A National Research Council report in the year 2000 describes this process of transitioning from an R&D platform to an operational platform as "Crossing the Valley of Death". Array's Scalable GSP technology has been engineered to support the evolution of prototypes into fully functional operational systems, through the use of an infrastructure that supports scalable processing, including the use of the open standard Message Passing Interface (MPI) and a technique of adding new functionality through the use of Generic Signal Processing Blocks (GSPBs). The increasing

global impact of severe weather has created a demand for shorter term weather forecasts, and thus for a more efficient processing of satellite data. Also, variability in weather can have a great impact on military operations and tactics, and the growing use of unmanned vehicles requires accurate short term weather forecasts. In order to meet these needs, data from existing satellite systems is now being used in novel ways to produce short term forecasts, or "nowcasts" where nowcasting is defined as forecasting up to a few hours into the future. For example, 10 minute segments of data from the ESA satellite ERS-2, is now being used to produce near real-time 'nowcasts' of swiftly moving weather systems in the seas around Europe. This new use of ERS-2 data came about in 2004, nearly nine years after the launch of ERS-2. In order to support the re-engineering of satellite ground processing, flexible data ingest and algorithm sequencing capabilities are required. GSPBs allow the signal processing chain to be re-ordered, and the Scalable GSP technology allows the user to configure new data streams and sources. In summary, we will demonstrate how the Scalable Generic Signal Processing architecture is extensible, and provides a unified approach to efficient ground processing of multi-platform Earth observations.

Document Type: Conference Paper

Source: Scopus

Lacava, T.^a , Greco, M.^{b c} , Di Leo, E.V.^a , Martino, G.^b ,
Pergola, N.^a , Sannazzaro, F.^b , Tramutoli, V.^{a b c}

Monitoring soil wetness variations by means of satellite passive microwave observations: The HYDROPTIMET study cases

(2005) *Natural Hazards and Earth System*

Science, 5 (4), pp. 583-592. Cited 2 times.

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Abstract

Soil moisture is an important component of the hydrological cycle. In the framework of modern flood warning systems, the knowledge of soil moisture is crucial, due to the influence on the soil response in terms of infiltration-runoff. Precipitation-runoff processes, in fact, are related to catchment's hydrological conditions before the precipitation. Thus, an estimation of these conditions is of significant importance to improve the reliability of flood warning systems. Combining such information with other weather-related satellite products (i.e. rain rate estimation) might represent a useful exercise in order to improve our capability to handle (and possibly mitigate or prevent) hydro-geological hazards. Remote sensing, in the last few years, has supported several techniques for soil moisture/wetness monitoring. Most of the satellite-based techniques use microwave data, thanks to the all-weather and all-time capability of these data, as well as to their high sensitivity to water content in the soil. On the other hand, microwave data are unfortunately highly affected by the presence of surface roughness or vegetation coverage within the instantaneous satellite field of view (IFOV). Those problems, consequently, strongly limit the efficiency and the reliability of traditional satellite techniques. Recently, using data coming from AMSU (Advanced Microwave Sounding Unit), flying aboard NOAA (National Oceanic and Atmospheric Administration) satellites, a new methodology for soil wetness

estimation has been proposed. The proposed index, called Soil Wetness Variation Index (SWVI), developed by a multi-temporal analysis of AMSU records, seems able to reduce the problems related to vegetation and/or roughness effects. Such an approach has been tested, with promising results, on the analysis of some flooding events which occurred in Europe in the past. In this study, results achieved for the HYDROPTIMET test cases will be analysed and discussed in detail. This analysis allows us to evaluate the reliability and the efficiency of the proposed technique in identifying different amounts of soil wetness variations in different observational conditions. In particular, the proposed indicator was able to document the actual effects of meteorological events, in terms of space-time evolution of soil wetness changes, for all the analysed HYDROPTIMET test cases. Moreover, in some circumstances, the SWVI was able to identify the presence of a sort of "early" signal in terms of soil wetness variations, which may be regarded as a timely indication of an anomalous value of soil water content. This evidence suggests the opportunity to use such an index in the pre-operational phases of the modern flood warning systems, in order to improve their forecast capabilities and their reliability. European Geosciences Union © 2005 Author(s). This work is licensed under a Creative Commons License.

Document Type: Article

Source: Scopus

Jaeglé, L.^a , Steinberger, L.^a , Martin, R.V.^{b c} , Chance, K.^c
Global partitioning of NO_x sources using satellite observations: Relative roles of fossil fuel combustion, biomass burning and soil emissions
(2005) *Faraday Discussions*, 130, pp. 407-

423. Cited 53 times.

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Abstract

We use space-based observations of NO₂ columns from the Global Ozone Monitoring Experiment (GOME) to derive monthly top-down NO_x emissions for 2000 via inverse modeling with the GEOS-CHEM chemical transport model. Top-down NO_x sources are partitioned among fuel combustion (fossil fuel and biofuel), biomass burning and soils by exploiting the spatio-temporal distribution of remotely sensed fires and a priori information on the location of regions dominated by fuel combustion. The top-down inventory is combined with an a priori inventory to obtain an optimized a posteriori estimate of the relative roles of NO_x sources. The resulting a posteriori fuel combustion inventory (25.6 TgN year⁻¹) agrees closely with the a priori (25.4 TgN year⁻¹), and errors are reduced by a factor of 2, from $\pm 80\%$ to $\pm 40\%$. Regionally, the largest differences are found over Japan and South Africa, where a posteriori estimates are 25% larger than a priori. A posteriori fuel combustion emissions are aseasonal, with the exception of East Asia and Europe where winter emissions are 30-40% larger relative to summer emissions, consistent with increased energy use during winter for heating. Global a posteriori biomass burning emissions in 2000 resulted in 5.8 TgN (compared to 5.9 TgN year⁻¹ in the a priori), with Africa accounting for half of this total. A posteriori biomass burning emissions over Southeast

Asia/India are decreased by 46% relative to a priori; but over North equatorial Africa they are increased by 50%. A posteriori estimates of soil emissions (8.9 TgN year⁻¹) are 68% larger than a priori (5.3 TgN year⁻¹). The a posteriori inventory displays the largest soil emissions over tropical savanna/woodland ecosystems (Africa), as well as over agricultural regions in the western U.S. (Great Plains), southern Europe (Spain, Greece, Turkey), and Asia (North China Plain and North India), consistent with field measurements. Emissions over these regions are highest during summer at mid-latitudes and during the rainy season in the Tropics. We estimate that 2.5-4.5 TgN year⁻¹ are emitted from N-fertilized soils, at the upper end of previous estimates. Soil and biomass burning emissions account for 22% and 14% of global surface NO_x emissions, respectively. We infer a significant role for soil NO_x emissions at northern mid-latitudes during summer, where they account for nearly half that of the fuel combustion source, a doubling relative to the a priori. The contribution of soil emissions to background ozone is thus likely to be underestimated by the current generation of chemical transport models. © The Royal Society of Chemistry 2005.

Document Type: Conference Paper

Source: Scopus

Hossain, F.^a , Anagnostou, E.N.^b

Using a multi-dimensional satellite rainfall error model to characterize uncertainty in soil moisture fields simulated by an offline land surface model

(2005) *Geophysical Research Letters*, 32 (15), art. no. L15402, . Cited 5 times.

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38505-0001, United States

^b Department of Civil and Environmental Engineering,
University of Connecticut, Storrs, CT 06269, United States

Abstract

In this study, we investigate the significance of using an improved error modeling strategy to characterize the spatio-temporal characteristics of uncertainty in simulation of soil moisture fields from an off-line land surface model forced with satellite rainfall data. We coupled a Two-Dimensional Satellite Rainfall Error Model (SREM2D) with the Common Land Model to propagate ensembles of simulated satellite rain fields for the prediction of soil moisture at depths of 5 cm (near surface) and 50 cm (root zone). Our investigations revealed that multi-dimensional error modeling captures the spatio-temporal characteristics of soil moisture uncertainty with higher consistency than simpler bi-dimensional error modeling strategies. The proposed error modeling strategy appears to have the potential for delineating a more robust framework for the optimal integration of satellite rainfall data into models towards the study of global water and energy cycle. Copyright 2005 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Aires, F.^a , Prigent, C.^b , Rossow, W.B.^c

**Sensitivity of satellite microwave and infrared
observations to soil moisture at a global scale: 2.
Global statistical relationships**

(2005) *Journal of Geophysical Research D*:

Atmospheres, 110 (11), pp. 1-14. Cited 4 times.

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^c NASA Goddard Institute for Space Studies, 2880 Broadway, New York, NY 10025, United States

Abstract

In part 1 of this study (Prigent et al., 2004), in situ measurements were used to analyze and describe the sensitivities of satellite measurements (i.e., active and passive microwave observations and surface skin temperature diurnal cycle amplitude) to the soil moisture variations to describe the complex relationships that exist between them. Soil moisture was considered in the first 10-cm layer on a 0.25° equal-area grid and a monthly timescale. In this study, the lessons from the first paper are exploited to document the sensitivity of the satellite data to the global large-scale variations of soil moisture. A statistical model based on neural networks is developed to link the satellite observations and soil moisture estimates. Given the lack of available in situ soil moisture measurements on a global basis, National Centers for Environmental Prediction (NCEP) and European Centre for Medium-Range Weather Forecasts (ECMWF) soil moisture reanalyses are used as a realistic global indicator of soil moisture. As a consequence, the statistical model cannot be considered as a retrieval scheme per se, but it shows the feasibility of such an approach. It also quantifies the information content that can be expected from the satellite observations. Applications of such a statistical model include

checking the consistency of surface model, and as the basis for variational assimilation of satellite observations into a numerical surface model. Copyright 2005 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Robin, J.^{a b}, Levine, E.^b, Riha, S.^c

Utilizing satellite imagery and GLOBE student data to model soil dynamics

(2005) *Ecological Modelling*, 185 (1), pp. 133-145. Cited 1 time.

^a University of Maryland, College Park, MD 20742, United States

^b Laboratory for Terrestrial Physics, NASA, Goddard Space Flight Center, Greenbelt, MD 20771, United States

^c Cornell University, Ithaca, NY 14853, United States

Abstract

General Purpose Atmosphere Plant Soil Simulator (GAPS), a menu-driven soil-vegetation-atmosphere transfer (SVAT) model, was used to simulate soil water dynamics from 1998 through 2001 for Greenville, PA, USA. GLOBE student data collected by students from Reynolds Junior and Senior High School, coupled with normalized difference vegetation index (NDVI) data derived from SPOT4 vegetation imagery, were used to parameterize and validate the model. Data from the National Weather Service Cooperative (NWSC) was used to evaluate the GLOBE dataset. Overall, there was a high index of agreement ($d > 0.80$) between field measurements and

simulated soil water values from both datasets (GLOBE and NWSC). Simulations using the GLOBE climate data outperformed the NWSC data for the 1999, 2000, and 2001 growing seasons. In addition, the GLOBE simulations showed that NDVI could be utilized to predict transpiration periods (QI, QII, and QIII) for northern latitudes $>35^{\circ}$ with a distinct winter period. In phenological terms, QI reflects the onset of the growing season when vegetation is greening up ($\text{NDVI} < 0.60$) and transpiration is beginning (<2 mm/day) and QII reflects the end of the growing seasons when vegetation is greening down and transpiration is decreasing. QIII reflects the height of the growing season when transpiration rates average between 2 and 5 mm per day and NDVI is at its maximum (>0.60). Results of this study demonstrate that GLOBE student data, coupled with remotely sensed data, can provide an important source of input and validation information for capacitance SVAT models such as GAPS. © 2004 Elsevier B.V. All rights reserved.

Author Keywords

Model; NDVI; Soil moisture; SVAT; Transpiration

Document Type: Article

Source: Scopus

Cashion, J.^a , Lakshmi, V.^a , Bosch, D.^b , Jackson, T.J.^c

Microwave remote sensing of soil moisture: Evaluation of the TRMM microwave imager (TMI) satellite for the Little River Watershed Tifton, Georgia

(2005) *Journal of Hydrology*, 307 (1-4), pp. 242-253. Cited 19 times.

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Carolina, Columbia, SC 29223, United States

^b Southeast Watershed Research Laboratory, US Department of Agriculture, Agricultural Research Service, P.O. Box 946, Tifton, GA 31793, United States

^c USDA-ARS, Hydrology and Remote Sensing Lab., Beltsville, MD 20705, United States

Abstract

Soil moisture plays a critical role in many hydrological processes including infiltration, evaporation, and runoff. Satellite-based passive microwave sensors offer an effective way to observe soil moisture conditions over vast areas. There are currently several satellite systems that can detect soil moisture. Calibration, validation, and characterization of data received from these satellite systems are an ongoing process. One approach to these requirements is to collect and compare long-term in situ (field) measurements of soil moisture with remotely sensed data. The in situ measurements for this paper were collected at the Little River Watershed (LRW) Tifton, Georgia and compared to the Tropical Rainfall Measurement Mission Microwave Imager (TMI) 10.65 GHz vertical and horizontal (V and H) sensors and vegetation density Normalized Difference Vegetation Index (NDVI) from the Moderate Resolution Imaging Spectroradiometer (MODIS) for the period from 1999 through 2002. The in situ soil moisture probes exist in conjunction with rain gauge stations throughout the sampling region. It was found that the TMI was able to observe soil moisture conditions when vegetation levels were low. However, during several months each year high vegetation levels mask the soil moisture signal from the TMI. When the monthly averaged observation from the TMI, MODIS, and in situ probes were subjected to a multivariable comparison the correlation value increased slightly, improving the accuracy of the TMI - soil

moisture correlation. Our results show that the TMI estimate would not result in an adequate monitoring of large land areas but when used in conjunction with other satellite sensors and in situ networks and model output can constitute an effective means of monitoring soil moisture of the land surface. © 2004 Elsevier B.V. All rights reserved.

Author Keywords

Hydrological processes; Microwave remote sensing; Soil moisture; Vegetation index

Document Type: Article

Source: Scopus

Lacava, T.^a , Cuomo, V.^a , Di Leo, E.V.^a , Pergola, N.^a ,
Romano, F.^a , Tramutoli, V.^{a b}

Improving soil wetness variations monitoring from passive microwave satellite data: The case of April 2000 Hungary flood

(2005) *Remote Sensing of Environment*, 96 (2), pp. 135-148. Cited 9 times.

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^b University of Basilicata, Department of Engineering and Physics, Environment Campus di Macchia Romana, Potenza, Italy

Abstract

Precipitation-runoff processes are correlated with catchment's hydrological conditions before the precipitation. Thus, an

estimation of these conditions, particularly regarding soil wetness variations, is of considerable importance to improve the reliability of flood warning. In this paper, a new methodology is presented which, on the basis of microwave satellite observations, could permit us to monitor soil wetness variations at a global scale. The proposed method seems able to overcome the problems connected to surface roughness and vegetation cover that mainly limit the soil moisture estimations from satellite in the microwave region. Preliminary results achieved for the flooding event which occurred in the Carpathian basin (Hungary) in April 2000 will be described in detail. They seem to confirm the reliability of the proposed technique in the identification of different amounts of soil wetness, not only during and after the considered event, but, in order to possibly use it for warning system purposes, in the phase preceding the event as well. Such an approach is automatic and, for construction, globally exportable. Moreover, because of the complete independence from the specific satellite platform, such a technique could be easily exported to the new generation of satellite sensors with improved performances like AMSR-E aboard EOS-Aqua and MIRAS aboard SMOS. © 2005 Elsevier Inc. All rights reserved.

Author Keywords

AMSU; Flood forecast; Passive microwave instruments; Satellite remote sensing; Soil moisture

Document Type: Article

Source: Scopus

Dobos, E.^{a b}, Micheli, E.^{b c}, Montanarella, L.^b

Soil organic matter map of Hungary derived from

digital elevation model and satellite data

(2005) *Cereal Research Communications*, 33 (1), pp. 361-364.

^a Fac. of Earth Sci. and Engineering, University of Miskolc, Hungary

^b European Commission, Joint Research Centre, Inst. of Environ. and Sustainability, Italy

^c Szent István University, Dept. of Soil Sci. and Agrochemistry, Gödöllo, Hungary

Abstract

The final map of the SOM content is shown on Fig. 1. The forward regression has selected 12 variables and the following regression equation was set up: $SOM_g/m^2 = ([\text{Square root transformed NDVI from Sept.}] * -1829.276) - ([\text{MODIS band 5, May}] * 1.469) - ([\text{Square root transformed PDD}] * 7626.015) + ([\text{PDD}] * 1240.775) - ([\text{Logaritmic transformed altitude}] * 12097.897) + ([\text{Relief Intensity}] * 54.247) + ([\text{MODIS NDVI, May}] * 105.134) - ([\text{MODIS band 3, May}] * 33.099) - ([\text{Profile convexity}] * 9179.56) + ([\text{Square root transformed MODIS band 1, May}] * 2556.134) - ([\text{MODIS band 4, May}] * 3.998) - ([\text{Aspect}] * 10.738) + 87921.241$

The adjusted R² was quite low, but significant, 0.238, meaning that there is significant correlation between the SOM content and terrain and spectral variables. Despite of the low statistical correlation, the overall look of the map looks promising. It coincides with our understanding about the spatial distribution of SOM content over Hungary, determined by the climatic, geologic, biotic and human impacts on the soil formation. The low R² value and the scatterplot intimate the complex nature of the SOM distribution, determined by important soil forming factors, which are not significantly represented by the satellite images or the terrain variables.

The results and the descriptive statistics need more thorough interpretation of the soil specialistst.

Document Type: Conference Paper

Source: Scopus

Martin, Y.E.^a , Franklin, S.E.^b

Classification of soil- and bedrock-dominated landslides in British Columbia using segmentation of satellite imagery and DEM data

(2005) *International Journal of Remote Sensing*, 26 (7), pp. 1505-1509. Cited 4 times.

^a Department of Geography, University of Calgary, Calgary, Alta. T2N 1N4, Canada

^b Department of Geography, University of Saskatchewan, Saskatoon, Sask. S7N 0W9, Canada

Abstract

Landsat Enhanced Thematic Mapper Plus (ETM+) and digital elevation model (DEM) data were used in a segmentation and classification procedure to classify slide scars in the northern Cascade Mountains of British Columbia, Canada. The area was stratified into features that were likely candidates for landsliding and those that were not; shape criteria were applied that were used to identify objects as slides; and finally, rules based on shape, texture and neighbouring features were used to separate soil-dominated slides from bedrock-dominated slides, an important distinction in mass movement inventories and for applied and theoretical studies. Approximately 65% classification accuracy was obtained. Slopes experiencing multiple failures, which can create less distinct features on the ground, may have contributed to

some of the error in classification. © 2005 Taylor & Francis Group Ltd.

Document Type: Article

Source: Scopus

Reichle, R.H.^{a b}, Koster, R.D.^a

Global assimilation of satellite surface soil moisture retrievals into the NASA catchment land surface model

(2005) *Geophysical Research Letters*, 32 (2), pp. 1-

4. Cited 32 times.

^a Global Modeling and Assimilation, NASA-GSFC, Greenbelt Rd, Greenbelt, MD 20771, United States

^b Goddard Earth Science/Technol. Ctr., University of Maryland, Baltimore, MD, United States

Abstract

Global retrievals of surface soil moisture from the Scanning Multichannel Microwave Radiometer for the period 1979-87 are assimilated into the NASA Catchment land surface model as it is driven with surface meteorological data derived from observations. Validation against ground-based measurements in Eurasia and North America from the Global Soil Moisture Data Bank demonstrates a long assumed (but rarely proven) property of soil moisture fields derived from data assimilation - that the assimilation product is superior to either satellite data or model data alone. An analysis of the innovations reveals that the filter is only partially operating within its underlying assumptions and offers clues how spatially distributed model error parameters could further enhance filter performance. Copyright 2005 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Fang, H.^a , Liang, S.^a , McClaran, M.P.^b , Van Leeuwen, W.J.D.^c , Drake, S.^c , Marsh, S.E.^c , Thomson, A.^d , Izaurrealde, R.C.^d , Rosenberg, N.J.^d

Deriving land surface biophysical parameters from satellite data for soil carbon sequestration

(2004) *International Geoscience and Remote Sensing Symposium (IGARSS)*, 6, pp. 4277-4280.

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^d Jt. Global Change Research Institute, University of Maryland, College Park, MD 20742, United States

Abstract

We apply a hybrid inversion algorithm to estimate land surface biophysical variables (e.g., leaf area index) from the CHRIS (Compact High Resolution Imaging Spectrometer), and ETM+. Field campaigns were conducted over Tucson, Arizona to validate the algorithms and the products. The derived products were compared for different human management activities. These products are then available for input to a plant growth model for calculating the potential for carbon sequestration.

Author Keywords

CHRIS; Leaf area index (LAI); Semi-arid rangeland;
Vegetation Index (VI)

Document Type: Conference Paper

Source: Scopus

Gautam, R.K., Panigrahi, S.

Development and evaluation of neural network based soil nitrate prediction models from satellite images and non imagery information

(2004) *ASAE Annual International Meeting 2004*, pp. 4309-4333.

Agricultural and Biosystems Engineering Department, North Dakota State University, Fargo, ND 58105

Abstract

LANDSAT TM satellite imagery and non-imagery information were applied to predict the residual soil nitrate content in Williston research site from three neural networks i.e., back propagation, radial basis function, and modular architectures. It was found that the modular neural network based residual soil nitrate prediction model yielded a root mean square error of prediction (RMSEP) of 11.37 (9.09%). The corresponding correlation coefficient of 0.81 (81%) was the highest among those provided by all three neural network models. This finding was similar to the previously developed (Transactions of the ASAE, under review) neural network prediction models. Hence, it is reclaimed that there is a high potential for predicting the residual soil nitrate content using imagery and non imagery information. The sensitivity analysis of input (imagery and non imagery) variables showed the relevance of

both imagery as well as non imagery information for predicting the residual soil nitrate content in field conditions.

Author Keywords

Back propagation; Data transformation; Durum crop; Modular neural network; Radial basis function; Residual soil nitrate content; Sensitivity analysis; Textural features

Document Type: Conference Paper

Source: Scopus

Owe, M.^a , Holmes, T.R.H.^b , De Jeu, R.A.M.^b

Spatial distributions of global soil moisture retrievals from satellite microwave observations

(2004) *Proceedings of SPIE - The International Society for Optical Engineering*, 5568, art. no. 29, pp. 171-178.

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^b Dept. of Geo-Environmental Sciences, Vrije Universiteit, De Boelelaan 1085, 1081 HV Amsterdam, Netherlands

Abstract

A global data base of daily surface soil moisture has been compiled by applying a recently developed land parameter retrieval algorithm to a nine year historical data set of brightness temperatures from the Scanning Multichannel Microwave Radiometer (SMMR). The instrument, flew on-board the Nimbus-7 satellite, and made daily daytime and nighttime global observations of brightness temperature at five frequencies and two polarizations from 1978 to 1987. Spatial distributions of global soil moisture are examined, and they compare well with corresponding observations of global

precipitation and global vegetation indices.

Author Keywords

Global climate; Microwave brightness temperature; Remote sensing; Soil moisture

Document Type: Conference Paper

Source: Scopus

Drunpob, A.^a , Chang, N.-B.^a , Beaman, M.^b , Wyatt, C.^c , Slater, C.^c

Soil moisture detection using RADASAT corner reflector enhanced satellite imagery in a semi-arid watershed with complex terrain

(2004) *Proceedings of SPIE - The International Society for Optical Engineering*, 5584, art. no. 33, pp. 267-275.

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Abstract

Measuring soil moisture turns out to be crucial in watershed management. This study presents soil moisture prediction using RADRASAT-1 Synthetic Aperture Radar (SAR) satellite imagery collected in the Choke Canyon Reservoir Watershed (CCRW) in April 2004. Essential radiometric and geometric calibrations to correct the SAR imagery were performed with

the aid of Corner Reflectors (CRs). The sensor data obtained after the installation of the corner reflectors in April 2004 showed better spatial accuracy, and consequently improves the correlation between the radar backscatter signals, σ_0 , and the Volumetric Moisture Content (VMC) of the soil in CCRW. Three prediction models were developed for soil moisture projection, which include simple linear regression, multiple linear regression, and genetic programming models. It found that the genetic programming model exhibits overall advantage of soil moisture estimation.

Author Keywords

Complex terrain; Corner reflector; Geometric calibration; Radiometric calibration; SAR; Satellite imagery; Semi-arid watershed; Soil moisture

Document Type: Conference Paper

Source: Scopus

Drunpob, A.^a, Chang, N.B.^a, Beaman, M.^b, Wyatt, C.^c

Soil moisture analysis using RADARSAT satellite image in the Choke Canyon Reservoir Watershed, South Texas
(2004) *International Geoscience and Remote Sensing Symposium (IGARSS)*, 5, pp. 3515-3518.

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^c Geophysical Institute, University of Alaska, Fairbanks, AK, United States

Abstract

The surface soil moisture is very difficult to measure on a river basin scale due to versatile soil types and their associated textures. Consistency of measuring in-situ soil moisture on site is barely obtainable even on a local scale. Recent advances in remote sensing technology have demonstrated that soil moisture can be measured systematically by many optical techniques, such as microwave technology of Synthetic Aperture Radar (SAR). It has the ability to quantitatively measure soil moisture under a variety of topographic and vegetation cover conditions from a satellite system. RADASAT-1 is a space borne SAR imagery satellite. With its all-weather capability, the RADASAT-1 is a promising tool for measuring the surface soil moisture. This research focuses on relations made to soil moisture variability within RADASAT-1 footprints and on the use of SAR images to develop models of surface soil moisture profile. The case study in the Choke Canyon Reservoir Watershed, South Texas reflects soil moisture spatial distribution patterns in the summer that can be viewed as an extreme situation of water resources management within a semi-arid coastal watershed in 2003.

Document Type: Conference Paper

Source: Scopus

Jaeglé, L.^a , Martin, R.V.^{b c} , Chance, K.^c , Steinberger, L.^a , Kurosu, T.P.^c , Jacob, D.J.^d , Modi, A.I.^e , Yoboué, V.^f , Sigha-Nkamdjou, L.^g , Galy-Lacaux, C.^h

Satellite mapping of rain-induced nitric oxide emissions from soils

(2004) *Journal of Geophysical Research D:*

Atmospheres, 109 (21), pp. D21310 1-10. Cited 35 times.

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Abstract

We use space-based observations of NO₂ columns from the Global Ozone Monitoring Experiment (GOME) to map the spatial and seasonal variations of NO_x emissions over Africa during 2000. The GOME observations show not only enhanced tropospheric NO₂ columns from biomass burning during the dry season but also comparable enhancements from soil emissions during the rainy season over the Sahel. These soil emissions occur in strong pulses lasting 1-3 weeks following the onset of rain, and affect 3 million km² of semiarid sub-Saharan savanna. Surface observations of NO₂ from the

International Global Atmospheric Chemistry (IGAC)/Deposition of Biochemically Important Trace Species (DEBITS)/Africa (IDAF) network over West Africa provide further evidence for a strong role for microbial soil sources. By combining inverse modeling of GOME NO₂ columns with space-based observations of fires, we estimate that soils contribute 3.3 ± 1.8 TgN/year, similar to the biomass burning source (3.8 ± 2.1 TgN/year), and thus account for 40% of surface NO_x emissions over Africa. Extrapolating to all the tropics, we estimate a 7.3 TgN/year biogenic soil source, which is a factor of 2 larger compared to model-based inventories but agrees with observation-based inventories. These large soil NO_x emissions are likely to significantly contribute to the ozone enhancement originating from tropical Africa. Copyright 2004 by the American Geophysical Union.

Author Keywords

NO_x; Satellite; Soil

Document Type: Article

Source: Scopus

Vicente-Serrano, S.M.^a, Pons-Fernández, X.^b, Cuadrat-Prats, J.M.^a

Mapping soil moisture in the central Ebro river valley (northeast Spain) with Landsat and NOAA satellite imagery: A comparison with meteorological data

(2004) *International Journal of Remote Sensing*, 25 (20), pp. 4325-4350. Cited 8 times.

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^b Departamento de Geografia, CREAM, Universitat Autònoma de Barcelona, Bellaterra 08193, Spain

Abstract

This paper analyses and maps the spatial distribution of soil moisture using remote sensing: National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR) and Landsat-Enhanced Thematic Mapper (ETM+) images. The study was carried out in the central Ebro river valley (northeast Spain), and examines the spatial relationships between the distribution of soil moisture and several meteorological and geographical variables following a long, intense dry period (winter 2000). Soil moisture estimates were obtained using thermal, visible and near-infrared data and by applying the 'triangle method', which describes relationships between surface temperature (T_s) and fractional vegetation cover (F_r). Low differences were found between the soil moisture estimates obtained using AVHRR and ETM+ sensors. Soil moisture estimated using remote sensing is close to estimations obtained from climate indices. This fact, and the high similarity between estimations of both sensors, suggests the reasonable reliability of soil moisture remote sensing estimations. Moreover, in estimations from both sensors the spatial distribution of soil moisture was largely accounted for by meteorological variables, mainly precipitation in the dry period. The results indicate the high reliability of remote sensing for determining areas affected by water deficits and for quantifying drought intensity. © 2004 Taylor and Francis Ltd.

Document Type: Article

Source: Scopus

Reichle, R.H.^{a b}, Koster, R.D.^a

Bias reduction in short records of satellite soil moisture

(2004) *Geophysical Research Letters*, 31 (19), pp. L19501 1-4. Cited 30 times.

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^b Goddard Earth Sci. and Technol. Ctr., University of Maryland, Baltimore, MD, United States

Abstract

Although surface soil moisture data from different sources (satellite retrievals, ground measurements, and land model integrations of observed meteorological forcing data) have been shown to contain consistent and useful information in their seasonal cycle and anomaly signals, they typically exhibit very different mean values and variability. These biases pose a severe obstacle to exploiting the useful information contained in satellite retrievals through data assimilation. A simple method of bias removal is to match the cumulative distribution functions (cdf) of the satellite and model data. However, accurate cdf estimation typically requires a long record of satellite data. We demonstrate here that by using spatial sampling with a 2 degree moving window we can obtain local statistics based on a one-year satellite record that are a good approximation to those that would be derived from a much longer time series. This result should increase the usefulness of relatively short satellite data records. Copyright 2004 by the American Geophysical Union.

Author Keywords

1866 Hydrology: Soil moisture; 3322 Meteorology and

Atmospheric Dynamics: Land/atmosphere interactions; 3337
Meteorology and Atmospheric Dynamics: Numerical modeling
and data assimilation; 3360 Meteorology and Atmospheric
Dynamics: Remote sensing

Document Type: Article

Source: Scopus

Moran, M.S.^a , Peters-Lidard, C.D.^b , Watts, J.M.^c , McElroy,
S.^a

**Estimating soil moisture at the watershed scale with
satellite-based radar and land surface models**

(2004) *Canadian Journal of Remote Sensing*, 30 (5), pp. 805-
826. Cited 36 times.

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Abstract

Spatially distributed soil moisture profiles are required for
watershed applications such as drought and flood prediction,
crop irrigation scheduling, pest management, and
determining mobility with lightweight vehicles. Satellite-based
soil moisture can be obtained from passive microwave, active
microwave, and optical sensors, although the coarse spatial

resolution of passive microwave and the inability to obtain vertically resolved information from optical sensors limit their usefulness for watershed-scale applications. Active microwave sensors such as synthetic aperture radar (SAR) currently represent the best approach for obtaining spatially distributed surface soil moisture at scales of 10-100 m for watersheds ranging from 1 000 to 25 000 km². Although SAR provides surface soil moisture, the applications listed above require vertically resolved soil moisture profiles. To obtain distributed soil moisture profiles, a combined approach of calibration and data assimilation in soil vegetation atmosphere transfer (SVAT) models based on recent advances in soil physics is the most promising avenue of research. This review summarizes the state of the science using current satellite-based sensors to determine watershed-scale surface soil moisture distribution and the state of combining SVAT models with data assimilation and calibration approaches for the estimation of profile soil moisture. The basic conclusion of this review is that currently orbiting SAR sensors combined with available SVAT models could provide distributed profile soil moisture information with known accuracy at the watershed scale. The priority areas for future research should include image-based approaches for mapping surface roughness, determination of soil moisture in densely vegetated sites, active and passive microwave data fusion, and joint calibration and data assimilation approaches for a combined remote sensing - modeling system. For validation, a worldwide in situ soil moisture monitoring program should be implemented. Finally, to realize the full potential of satellite-based soil moisture estimation for watershed applications, it will be necessary to continue sensor development, improve image availability and timely delivery, and reduce image cost.

Document Type: Review

Source: Scopus

Entekhabi, D.^a, Njoku, E.G.^b, Houser, P.^c, Spencer, M.^b,
Doiron, T.^c, Kim, Y.^b, Smith, J.^b, Girard, R.^d, Belair, S.^e,
Crow, W.^f, Jackson, T.J.^f, Kerr, Y.H.^g, Kimball, J.S.^h,
Koster, R.^c, McDonald, K.C.^b, O'Neill, P.E.^c, Pultz, T.ⁱ,
Running, S.W.^h, Shi, J.^j, Wood, E.^k, Van Zyl, J.^b

The hydrosphere state (hydros) satellite mission: An earth system pathfinder for global mapping of soil moisture and land freeze/thaw

(2004) *IEEE Transactions on Geoscience and Remote Sensing*, 42 (10), pp. 2184-2195. Cited 81 times.

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Abstract

The Hydrosphere State Mission (Hydros) is a pathfinder mission in the National Aeronautics and Space Administration (NASA) Earth System Science Pathfinder Program (ESSP). The objective of the mission is to provide exploratory global measurements of the earth's soil moisture at 10-km resolution with two- to three-days revisit and land-surface freeze/thaw conditions at 3-km resolution with one- to two-days revisit. The mission builds on the heritage of ground-based and airborne passive and active low-frequency microwave measurements that have demonstrated and validated the effectiveness of the measurements and associated algorithms for estimating the amount and phase (frozen or thawed) of surface soil moisture. The mission data will enable advances in weather and climate prediction and in mapping processes that link the water, energy, and carbon cycles. The Hydros instrument is a combined radar and radiometer system operating at 1.26 GHz (with VV, HH, and HV polarizations) and 1.41 GHz (with H, V, and U polarizations), respectively. The radar and the radiometer share the aperture of a 6-m antenna with a look-angle of 39° with respect to nadir. The lightweight deployable mesh antenna is rotated at 14.6 rpm to provide a constant look-angle scan across a swath width of 1000 km. The wide swath provides global coverage that meet the revisit requirements. The radiometer measurements allow retrieval of soil moisture in diverse (nonforested) landscapes with a resolution of 40

km. The radar measurements allow the retrieval of soil moisture at relatively high resolution (3 km). The mission includes combined radar/radiometer data products that will use the synergy of the two sensors to deliver enhanced-quality 10-km resolution soil moisture estimates. In this paper, the science requirements and their traceability to the instrument design are outlined. A review of the underlying measurement physics and key instrument performance parameters are also presented.

Author Keywords

Land freeze/thaw; Microwave remote sensing; Satellites; Soil moisture

Document Type: Conference Paper

Source: Scopus

Cosh, M.H.^a, Jackson, T.J.^a, Bindlish, R.^b, Prueger, J.H.^c

Watershed scale temporal and spatial stability of soil moisture and its role in validating satellite estimates

(2004) *Remote Sensing of Environment*, 92 (4), pp. 427-435. Cited 43 times.

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^c USDA ARS Natl. Soil Tilth Laboratory, Ames, IA, United States

Abstract

Watershed scale soil moisture estimates are necessary to validate current remote sensing products, such as those from

the Advanced Microwave Scanning Radiometer (AMSR). Unfortunately, remote sensing technology does not currently resolve the land surface at a scale that is easily observed with ground measurements. One approach to validation is to use existing soil moisture measurement networks and scale these point observations up to the resolution of remote sensing footprints. As part of the Soil Moisture Experiment 2002 (SMEX02), one such soil moisture gaging system in the Walnut Creek Watershed, Iowa, provided robust estimates of the soil moisture average for a watershed throughout the summer of 2002. Twelve in situ soil moisture probes were installed across the watershed. These probes recorded soil moisture at a depth of 5 cm from June 29, 2002 to August 19, 2002. The sampling sites were analyzed for temporal and spatial stability by several measures including mean relative difference, Spearman rank, and correlation coefficient analysis. Representative point measurements were used to estimate the watershed scale (~ 25 km) soil moisture average and shown to be accurate indicators with low variance and bias of the watershed scale soil moisture distribution. This work establishes the validity of this approach to provide watershed scale soil moisture estimates in this study region for the purposes of satellite validation with estimation errors as small as 3%. Also, the potential sources of error in this type of analysis are explored. This study is a first step in the implementation of large-scale soil moisture validation using existing networks such as the Soil Climate Analysis Network (SCAN) and several Agricultural Research Service watersheds as a basis for calibrating satellite soil moisture products, for networks design, and designing field experiments. © 2004 Elsevier Inc. All rights reserved.

Author Keywords

Advanced Microwave Scanning Radiometer; Soil moisture; Temporal and spatial stability

Document Type: Conference Paper

Source: Scopus

Walker, J.P.^{a b}, Houser, P.R.^a

Requirements of a global near-surface soil moisture satellite mission: Accuracy, repeat time, and spatial resolution

(2004) *Advances in Water Resources*, 27 (8), pp. 785-801. Cited 25 times.

^a Hydrological Sciences Branch, Lab. for Hydrospheric Processes, NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States

^b Dept. of Civil and Environ. Eng., The University of Melbourne, Parkville, Vic. 3010, Australia

Abstract

Soil moisture satellite mission accuracy, repeat time and spatial resolution requirements are addressed through a numerical twin data assimilation study. Simulated soil moisture profile retrievals were made by assimilating near-surface soil moisture observations with various accuracy (0, 1, 2, 3, 4, 5 and 10%v/v standard deviation) repeat time (1, 2, 3, 5, 10, 15, 20 and 30 days), and spatial resolution (0.5, 6, 12 18, 30, 60 and 120 arc-min). This study found that near-surface soil moisture observation error must be less than the model forecast error required for a specific application when used as data assimilation input, else slight model forecast degradation may result. It also found that near-surface soil moisture observations must have an accuracy better than 5%v/v to positively impact soil moisture forecasts, and that daily near-surface soil moisture

observations achieved the best soil moisture and evapotranspiration forecasts for the repeat times assessed, with 1-5 day repeat times having the greatest impact. Near-surface soil moisture observations with a spatial resolution finer than the land surface model resolution (~ 30 arc-min) produced the best results, with spatial resolutions coarser than the model resolution yielding only a slight degradation. Observations at half the land surface model spatial resolution were found to be appropriate for our application. Moreover, it was found that satisfying the spatial resolution and accuracy requirements was much more important than repeat time. © 2004 Published by Elsevier Ltd.

Author Keywords

Data assimilation; Mission requirements; Modelling; Remote sensing; Soil moisture

Document Type: Article

Source: Scopus

Reichle, R.H.^{a b}, Koster, R.D.^b, Dong, J.^{a b}, Berg, A.A.^c

Global soil moisture from satellite observations, land surface models, and ground data: Implications for data assimilation

(2004) *Journal of Hydrometeorology*, 5 (3), pp. 430-442. Cited 39 times.

^a Goddard Earth Sciences/Technol. Ctr., University of Maryland, Baltimore, United States

^b Global Modeling/Assimilation Office, NASA Goddard Space Flight Center, Greenbelt Road, Greenbelt, MD 20771, United States

^c Department of Geography, University of Guelph, Guelph, Ont., Canada

Abstract

Three independent surface soil moisture datasets for the period 1979-87 are compared: 1) global retrievals from the Scanning Multichannel Microwave Radiometer (SMMR), 2) global soil moisture derived from observed meteorological forcing using the NASA Catchment Land Surface Model, and 3) ground-based measurements in Eurasia and North America from the Global Soil Moisture Data Bank. Time-average soil moisture fields from the satellite and the model largely agree in the global patterns of wet and dry regions. Moreover, the time series and anomaly time series of monthly mean satellite and model soil moisture are well correlated in the transition regions between wet and dry climates where land initialization may be important for seasonal climate prediction. However, the magnitudes of time-average soil moisture and soil moisture variability are markedly different between the datasets in many locations. Absolute soil moisture values from the satellite and the model are very different, and neither agrees better with ground data, implying that a "correct" soil moisture climatology cannot be identified with confidence from the available global data. The discrepancies between the datasets point to a need for bias estimation and correction or resealing before satellite soil moisture can be assimilated into land surface models. © 2004 American Meteorological Society.

Document Type: Article

Source: Scopus

Srivastava, R., Saxena, R.K.

Technique of large-scale soil mapping in basaltic terrain using satellite remote sensing data

(2004) *International Journal of Remote Sensing*, 25 (4), pp. 679-688. Cited 2 times.

ICAR, Amravati Road, Maharashtra, Nagpur 440010, India

Abstract

The present paper discusses the technique of large-scale soil mapping using remote sensing data. IRS-1C PAN merged data of two seasons, namely late Kharif (monsoon) and Rabi (post rainy season), were interpreted visually in conjunction with Survey of India (SOI) toposheet (1:50 000 scale) and available ground data to prepare the physiography-land use (PLU) map. The PLU delineation explained a three-tier approach comprising landform, slope and land use characteristics of a given parcel of land. The first letter in the PLU legend indicates the landform, the second letter denotes slope percentage and the third letter indicates the land use characteristics. Soils occurring in different PLU units were examined and a PLU-soil relationship was developed. The soil map depicting phases of soil series was prepared using ILWIS software. © 2004 Taylor and Francis Ltd.

Document Type: Article

Source: Scopus

Sahebi, M.R., Bonn, F., Bénié, G.B.

Neural networks for the inversion of soil surface parameters from synthetic aperture radar satellite data

(2004) *Canadian Journal of Civil Engineering*, 31 (1), pp. 95-108. Cited 6 times.

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Sherbrooke, QC J1K 2R1, Canada

Abstract

This paper presents an application of neural networks to the extraction of bare soil surface parameters such as roughness and soil moisture content using synthetic aperture radar (SAR) satellite data. It uses a fast learning algorithm for training a multilayer feedforward neural network using the Kalman filter technique. Two different databases (theoretical and empirical) were used for the learning stage. Each database was configured as single and multiangular sets of input data (data acquired at two different incidence angles) that are compatible with data from one and two satellite images, respectively. All the configurations are trained and then evaluated using RADARSAT-1 and simulated data. The empirical (measured) database with the multiangular set of input data configuration had the best accuracy with a mean error of 1.54 cm for root mean square (rms) height of the surface roughness and 2.45 for soil dielectric constant in the study area. Based on these results the proposed approach was applied on RADARSAT-1 images from the Chateauguay watershed area (Quebec, Canada) and the final results are presented in the form of roughness and humidity maps. © 2004 NRC Canada.

Author Keywords

Kalman filter; Neural networks; RADARSAT; SAR; Soil moisture; Soil roughness

Document Type: Article

Source: Scopus

Tüfekçi, K., Akman, A. Ü.

Soil moisture assessment in the alluvial basins

associated with seismic activity of northwest Anatolia, Turkey, using Landsat TM/ETM satellite imagery
(2004) *Hydrological Sciences Journal*, 49 (1), pp. 171-182. Cited 1 time.

Remote Sensing Center, MTA, Ankara 06520, Turkey

Abstract

The aim of this study is to detect seasonal surface temperature changes and to estimate soil moisture conditions based on the evaporative cooling principle of damp ground in the alluvial basins of northwest Anatolia, Turkey, using Landsat TM/ETM data. According to analysis of satellite sensor data acquired on different dates, soil moisture is greatest in the spring season in the basins. Soil moisture decreases toward the summer and autumn. The 17 August 1999 earthquake occurred in the high surface temperature (low soil moisture) period, and the 12 November 1999 earthquake occurred in the low surface temperature (high soil moisture) period. It is possible to conclude that the urban-rural settlements and industrial developments on the loose deposits of the Adapazari, Izmit and Düzce depressions have been affected by the seasonal changes in the local ground conditions.

Author Keywords

Alluvial basin; Northwest Anatolia; Seismic activity; Soil moisture; Temperature; Thermal data; Turkey

Document Type: Article

Source: Scopus

Jones, A.S., Vukićević, T., Vonder Haar, T.H.

A microwave satellite observational operator for

variational data assimilation of soil moisture

(2004) *Journal of Hydrometeorology*, 5 (1), pp. 213-229. Cited 4 times.

Center for Geosciences/Atmosph. Res., Coop. Inst. for Res. in Atmosphere, Colorado State University, Fort Collins, CO 80523, United States

Abstract

An observational operator and its adjoint have been created that are suitable for use within variational data assimilation using polarized 6- and 10-GHz passive microwave satellite observations. When used within a variational data assimilation system, the operator will facilitate NWP soil moisture initialization using existing and future satellite datasets [e.g., NASA Advanced Microwave Scanning Radiometer-Earth Observing System (AMSR-E). Advanced Earth Observing Satellite II (ADEOS-II). Department of Defense (DoD) WindSat, and the National Polar Orbiter Environmental Satellite System (NPOESS) Conical Microwave Imager Sounder (CMIS)]. Five primary control variables are used within the operator, and surface soil moisture is explicitly included as one of the control variables. In future studies, this operator and its adjoint will be used to perform land surface model data assimilation experiments to better determine important NWP surface characteristics. In the current study, the adjoint model development and analysis of the potential information content of passive microwave measurements sensitive to the land surface and soil parameters are focused on. The multivariate results clarify the effects of masking phenomena upon the soil moisture signal. Also included is a useful transformation of the adjoint between real and complex number spaces. The transformations are necessary when higher-level mathematical operators, such as powers, use complex

number arguments. This can be a common occurrence within radiative transfer models. Thus, the adjoint of this particular observational operator serves as an example of this behavior. Various observational operator results and sensitivity analyses are presented, demonstrating significant utility of the operator for NWP soil moisture data assimilation studies.
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Document Type: Article

Source: Scopus

Wang, L., Zhang, X., Chen, X.

Applications of NOAA Weather Satellite Data to the Estimates of Topographic Height and Retrieval of Soil Moisture in Ningxia

(2003) *Proceedings of SPIE - The International Society for Optical Engineering*, 4890 (2), pp. 820-829.

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750002, China

Abstract

Marked by high efficiency, multiple channels and low cost, meteorological satellites have the applications extending from the use only in a meteorological context to quite a few scopes of research and operation. This paper introduces the establishment of statistical models between altitudes of stations at different latitudes/longitudes and corresponding NOAA/AVHRR remote sensing data to obtain the terrain altitudes in Ningxia and its surroundings whereupon the heights of different parts of Ningxia are found, with the results applied to the retrieval of spring soil moisture, thereby leading to the construction of soil moisture retrieval models from satellite data and altitudes for real-time monitoring soil

moisture. Results show that it is successful to make verification of satellite-data calculated altitudes against measurements, which, when introduced into the soil moisture retrieval models, improve the accuracy to greater extent. On this basis we developed the operational models for remote sensing based spring soil moisture monitoring in the target region that are run in an easy, quick and visual way, thus providing an efficient means of farmland soil moisture/dryness distributions monitoring.

Document Type: Conference Paper

Source: Scopus

Laymon, C.A., Crosson, W.L., Limaye, A.

Validation of Aircraft and Satellite Remote Sensing of Brightness Temperature and Derived Soil Moisture using a Hydrologic/Radiobrightness Model

(2003) *International Geoscience and Remote Sensing Symposium (IGARSS)*, 2, pp. 899-901.

Natl. Space Sci./Technology Center, 320 Sparkman Dr.,
Huntsville, AL 35805, United States

Abstract

This investigation is aimed at using a coupled hydrologic/radiobrightness model to validate remotely sensed brightness temperatures measured from aircraft and the satellite and derived soil moisture. The advantage of this approach is that the model can bridge the discontinuities in space and time among many observations at disparate scales and provide estimates of measurement uncertainty. This effort was focused on data generated during the Soil Moisture Experiments in 2002. Results are preliminary at this time and have served to raise numerous questions that are directing

current and future research.

Author Keywords

AMSR; Hydrologic modeling; Radiobrightness; Remote sensing; Soil moisture

Document Type: Conference Paper

Source: Scopus

Pathmathevan, M.^a , Koike, T.^a , Li, X.^b

A new satellite-based data assimilation algorithm to determine spatial and temporal variations of soil moisture and temperature profiles

(2003) *Journal of the Meteorological Society of Japan*, 81 (5), pp. 1111-1135. Cited 6 times.

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^b Cold/Arid Regions Environmental, Engineering Research Institute, Chinese Academy of Sciences, Lanzhou, China

Abstract

This paper focuses on the development and application of a new One-Dimensional Variational (1DVAR) data assimilation algorithm for estimating the spatial and temporal variations of soil moisture and temperature profiles, by grid-based analysis using remote sensing and in situ observations. This algorithm employs a heuristic optimization approach, simulated annealing (SA), which is capable of minimizing the Variational cost function without using adjoint models. The present assimilation scheme assimilates passive microwave remote sensing observations of brightness temperature into the land surface scheme (LSS), Simple Biosphere Model2 (SiB2). The

LSS is used as a model operator, and a Radiative Transfer Model (RTM) is used as an observational operator. The modeling system has been applied, and validated, using data from the GAME-Tibet (Global Energy and Water cycle Experiment (GEWEX) Asian Monsoon Experiment in Tibet) mesoscale field experiment. Compared to SiB2, our assimilation scheme solves the major initialization problem, and estimates the soil temperature and soil moisture at the surface layer and in the root zone with significant improvements.

Document Type: Article

Source: Scopus

Hirabayashi, Y., Oki, T., Kanae, S., Musiake, K.

Application of satellite-derived surface soil moisture data to simulating seasonal precipitation by a simple soil moisture transfer method

(2003) *Journal of Hydrometeorology*, 4 (5), pp. 929-943. Cited 6 times.

Institute of Industrial Science, The University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8505, Japan

Abstract

A simple algorithm is presented for transferring root-zone soil moisture from surface soil moisture data on a global scale. Analysis of offline soil moisture data shows that the climatological relationship between surface and root-zone soil moisture becomes linear when appropriate time lags are applied. The climatological relationship of root-zone soil moisture among different land surface models (LSMs) is also linear; therefore, the root-zone and surface soil moisture obtained from one LSM can be applied to another. The

algorithm is then applied to the surface soil moisture observations made by the precipitation radar on board the Tropical Rainfall Measuring Mission precipitation radar (TRMM/PR), and the transferred root-zone soil moisture is input to a general circulation model (GCM) summer-June, July, August-precipitation simulation as the boundary condition. The approach is computationally efficient, and the simulation using the root-zone soil moisture by the transfer method is much better than a simulation using root-zone soil moisture without the transfer method, assuming that the volumetric percentage of TRMM/PR is representative of the root zone. The result indicates that the simple transfer process will increase the utility of surface soil moisture data for a GCM.

Document Type: Article

Source: Scopus

Ahmad, M.-U.-D.^{a b}, Bastiaanssen, W.G.M.^c

Retrieving soil moisture storage in the unsaturated zone using satellite imagery and bi-annual phreatic surface fluctuations

(2003) *Irrigation and Drainage Systems*, 17 (3), pp. 141-161. Cited 5 times.

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^c WaterWatch, Generaal Foulkesweg 28, Wageningen, BS 6703, Netherlands

Abstract

Ongoing research into net groundwater use in Pakistan needed soil moisture storage information to compute monthly soil water balances. A methodology is developed to retrieve soil moisture storage in the complete unsaturated zone from root zone soil moisture content (based on thermal satellite imagery) and bi-annual phreatic surface fluctuations. A root mean square error in volumetric soil moisture content of 0.05 cm³ cm⁻³ in the root zone of irrigated fields was found for the case study in Pakistan. A new simple parameterisation of matric pressure head distribution between the root zone and the phreatic surface was developed. The absolute root mean square error in daily estimates of unsaturated zone storage for shallow (2 m) and deep groundwater tables (10 m) was found to be 7 cm (the average total storage is 110 cm). It is concluded that the spatial variation of the soil moisture storage depends on the depth of the phreatic surface, whereas the temporal variation is mainly controlled by the root zone soil moisture changes. The results show that for an area of 3 million ha, storage changes of ± 10 cm month⁻¹ occur, which is a significant quantity for monthly water balance analysis. Conventional methods such as specific yield do not consider moisture changes in the irrigated top soil when the groundwater table is deep. The new method is, therefore, a possible alternative solution, especially in areas where hydrological data is scanty.

Author Keywords

Evaporative fraction; Pakistan; Phreatic surface; Rechna Doab; Remote sensing; Soil moisture content; Soil moisture storage; Unsaturated zone

Document Type: Article

Source: Scopus

Morland, J.^{a b}, Metcalfe, J.^{a c}, Walker, A.^{a c}

Microwave remote sensing of soil moisture in southern Ontario: Aircraft and satellite measurements at 19 and 37 GHz

(2003) *Radio Science*, 38 (4), pp. MAR381-MAR389. Cited 4 times.

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^c Climate Research Branch, Meteorological Service of Canada, 4905 Dufferin Street, Downsview, Ont., M3H 5T4, Canada

Abstract

Aircraft microwave radiometer measurements at 19 and 37 GHz were made over a 40 km² agricultural area in southern Ontario on 16 and 23 May 2001 when the average soil moisture in the area was 28 and 40%, respectively. SSM/I satellite data and ground-based measurements of soil moisture were collected over the period 2 May to 25 July 2001. The emissivity of a water body (Lake Huron) calculated from the aircraft and satellite microwave radiometer measurements agreed with model calculations to within 0.02, except for the aircraft 37 GHz V channel. The 19 GHz emissivity measured by the SSM/I was higher than coincident aircraft measurements by 0.02 in moister soil conditions and 0.04 in drier conditions. Vegetation height increased from a maximum of 40 cm in hay fields in May to up to 200 cm in corn fields in July. There was a statistically significant relationship between soil moisture and 19 GHz H data for aircraft and SSM/I measurements in May. However, the

standard error in the soil moisture estimate was 7%. Soil moisture seemed to have very little influence on 19 and 37 GHz emission during June and July. When the mean monthly emissivity for the May to July period was calculated from the SSM/I data, there was found to be no significant variation from month to month.

Author Keywords

Aircraft measurements; Land surface emissivity; Microwave radiometers; Soil moisture; SSM/I

Document Type: Article

Source: Scopus

Tuomisto, H.^a , Poulsen, A.D.^b , Ruokolainen, K.^a , Moran, R.C.^{b d} , Quintana, C.^c , Celi, J.^c , Cañas, G.^c

Linking floristic patterns with soil heterogeneity and satellite imagery in Ecuadorian Amazonia

(2003) *Ecological Applications*, 13 (2), pp. 352-371. Cited 53 times.

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^b Department of Systematic Botany, Aarhus University, Nordlandsvej 68, DK-8240 Risskov, Denmark

^c Depto. de Ciencias Biológicas, Herbario QCA, Pont. Univ. Catol. del Ecuador, Av. 12 de Octubre # 1076 y Carrion, Quito, Ecuador

^d New York Botanical Garden, Bronx, NY 10458-5126, United States

Abstract

Floristic ground surveys in tropical rain forests are laborious and time consuming, so we tested to what degree reflectance differences visible in Landsat Thematic Mapper (TM) satellite images can be used to predict differences in floristic composition and species richness among rain forest sites. To gain ecological understanding of the rain forest ecosystem, we also tested to what extent variation in these vegetation characteristics can be explained by edaphic site conditions. The study was conducted in a relatively homogeneous area of Amazonian rain forest in Yasuní National Park, Ecuador. We established 27 transects of 5 m x 500 m within an area of ~20 km x 25 km to study edaphic and floristic patterns mainly within the tierra firme (non-inundated) forest. In each transect, soil samples were collected for chemical and textural analyses, and the abundance of each species belonging to two understory plant groups, pteridophytes (ferns and fern allies) and the Melastomataceae, was assessed. Floristic similarity between transect pairs varied widely and ranged from almost no overlap in species composition to very high overlap. The among-transect floristic similarity patterns of the two plant groups were strongly correlated with each other no matter whether presence-absence or abundance data were used. The floristic similarity patterns were also strongly correlated with the similarity in pixel values of the infrared bands in the Landsat TM satellite image and with the similarity in most of the measured soil variables. Similarity in species richness, on the contrary, was neither correlated with similarity in pixel values nor with similarity in most of the soil variables. We conclude that reflectance patterns in satellite images can be efficiently used to predict landscape-scale floristic and edaphic patterns in tierra firme rain forest. Predicting patterns in species richness, on the other hand, is not possible in the same straightforward manner. These results have important practical implications for land use and conservation planning as well as forecological and biodiversity research.

Author Keywords

Amazonia; Floristic composition; Mantel test;
Melastomataceae; Principal coordinates analysis;
Pteridophytes; Satellite imagery; Soils; Species richness;
Tropical rain forest

Document Type: Article

Source: Scopus

Font, J.^a , Lagerloef, G.S.E.^b , Le Vine, D.^c , Camps, A.^d
**Open issues for the soil moisture and ocean salinity
(SMOS) satellite mission salinity retrieval**
(2003) *European Space Agency, (Special Publication) ESA
SP, (525), pp. 7-13.*

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de Catalunya, Campus Nord D3, Jordi Girona 1-3, 08034
Barcelona, Spain

Abstract

After the different contributions presented at the SMOS
Campaigns Workshop, it is clear that this successful
exploratory campaigns had provided some key preliminary
results on the sensitivity of TB to wind speed in the function
of incidence angle. The main issue is to develop a consensus

WISE model for the dependence of TB on sea surface roughness as a function of polarization, incidence and azimuth angles, wind speed, sea surface height and foam.

Document Type: Article

Source: Scopus

Hutchinson, J.M.S.

Estimating near-surface soil moisture using active microwave satellite imagery and optical sensor inputs
(2003) *Transactions of the American Society of Agricultural Engineers*, 46 (2), pp. 225-236. Cited 3 times.

Department of Geography, Kansas State University, 118
Seaton Hall, Manhattan, KS 66506, United States

Abstract

Recent advances in radar remote sensing techniques illustrate the potential for monitoring soil moisture conditions at spatial and temporal scales required for regional and local modeling efforts. This research examined the feasibility of producing accurate and spatially distributed estimates of soil moisture using a time series of ERS-2 radar images for a tallgrass prairie ecosystem in northeast Kansas. Methods used included field data collection of soil moisture, digital image interpretation of optical (NOAA AVHRR and LANDSAT TM) and radar (ERS-2) imagery, and environmental modeling in a raster geographic information system (GIS) and image processing environment. Critical to this study was determining the scattering behavior of overlying vegetation, or the contribution of vegetation backscatter (σ_{veg}) to the total backscatter coefficient (σ_{total}), which was simulated using a modified water cloud model. By removing σ_{veg} from σ_{total} , the amount of backscatter contributed by the soil

surface (σ_{soil}) was isolated and the linear relationship between σ_{soil} and volumetric soil moisture determined. Single-date correlations averaged $r = 0.62$ and $r = 0.67$ for a burned and unburned watershed, respectively, within the study area. While previous studies have questioned the sensitivity of C-band radars to near-surface soil moisture conditions, these results show that ERS-2 data may be capable of monitoring soil moisture conditions over even extremely dense natural grassland vegetation.

Author Keywords

Grasslands; Models; Radar; Remote sensing; Soil water; Soil water content

Document Type: Article

Source: Scopus

Jackson, T.J.^a, Hsu, A.Y.^a, O'Neill, P.E.^b

Surface soil moisture retrieval and mapping using high-frequency microwave satellite observations in the Southern Great Plains

(2002) *Journal of Hydrometeorology*, 3 (6), pp. 688-699. Cited 14 times.

^a USDA-ARS Hydrol./Remote Sensing Lab., Beltsville, MD, United States

^b Hydrological Sciences Branch, Lab. for Hydrospheric Processes, NASA Goddard Space Flight Center, Greenbelt, MD, United States

Abstract

Studies have shown the advantages of low-frequency (<5 GHz) microwave sensors for soil moisture estimation.

Although higher frequencies have limited soil moisture retrieval capabilities, there is a vast quantity of systematic global high-frequency microwave data that have been collected for 15 yr by the Special Sensor Microwave Imager (SSM/I). SSM/I soil moisture studies have mostly utilized antecedent precipitation indices as validation, while only a few have employed limited ground observations, which were typically not optimal for this particular type of satellite data. In the Southern Great Plains (SGP) hydrology experiments conducted in 1997 and 1999, ground observations of soil moisture were made over an extended region for developing and validating largescale mapping techniques. Previous studies have indicated the limitations of both the higher-frequency data and models for soil moisture retrieval. Given these limitations, an alternative retrieval technique that utilizes multipolarization observations was implemented and tested for the SGP region. A technique for extracting algorithm parameters from the observations was developed and tested. The algorithm was then used to produce soil moisture maps of the region for the two study periods.

Document Type: Article

Source: Scopus

Djepa, V.^a, Menenti, M.^b, Vaughan, R.^a

Relating satellite multiangular thermal infrared observations to soil and foliage temperature

(2002) *Advances in Space Research*, 30 (11), pp. 2529-2533.

^a Department APEME, Ewing Building University of Dundee, Nethergate, Dundee DD1 4HN, United Kingdom

^b Université Louis Pasteur, 5 Blvd. S Brant, Illkirch 67400,

France

Abstract

The anisotropy of thermal infrared (TIR) radiance emitted by terrestrial targets comprising a mixture of soil and foliage is well documented by both ground and space - based radiometric data. Since TIR radiance depends on surface temperature and surface emissivity, observed anisotropy can be interpreted in terms of either anisotropy in emissivity or, for heterogeneous terrestrial targets, of differences in component temperatures. This paper focuses on the latter. A simple linear mixing model is proposed to relate the component temperatures of soil and foliage to the radiance emitted by a soil - foliage mixture. The underlying assumptions are briefly reviewed. It is finally shown that the simple linear model can be used to retrieve soil and foliage component temperatures from radiometric observations at different view angles. This is illustrated with a case - study based on TIR radiometric data collected by the Along Track Scanning Radiometer (ATSR-2) on board the ERS- 2 during the SGP'97 and HEIFE experiments. ©2002 COSPAR. Published by Elsevier Science Ltd. All rights reserved.

Document Type: Article

Source: Scopus

Lawrence, W.T., Imhoff, M.L., Kerle, N., Stutzer, D.

Quantifying urban land use and impact on soils in Egypt using diurnal satellite imagery of the earth surface

(2002) *International Journal of Remote*

Sensing, 23 (19), pp. 3921-3937. Cited 9 times.

Department of Natural Sciences, Bowie State University,
Bowie, MD 20715, United States

Abstract

Conversion of agricultural land to urban use represents a potential loss of agricultural productivity, especially in areas where arable land is in short supply. Using derived products from both daytime (Landsat sensor data) and night-time imaging systems (U.S. Air Force Defense Meteorological Satellite Program's Operational Linescan System (DMSP/OLS)) we examined the impacts of urbanization on soils in Egypt; a country with very limited agricultural land. We concluded that urban land cover types to occupy 3.7% of the total area of Egypt and that over 30% of the soils most suitable for agriculture are under urban land cover. Analysis of multiyear historical DMSP/OLS data sets (digitized from paper images) proved unreliable for long-term urban growth estimates.

Document Type: Article

Source: Scopus

Adegoke, J.O., Carleton, A.M.

Relations between soil moisture and satellite vegetation indices in the U.S. Corn Belt

(2002) *Journal of Hydrometeorology*, 3 (4), pp. 395-405. Cited 11 times.

Science and Applications Branch, USGS EROS Data Center,
47914 252nd St., Sioux Falls, SD 57198, United States

Abstract

Satellite-derived vegetation indices extracted over locations representative of midwestern U.S. cropland and forest for the period 1990-94 are analyzed to determine the sensitivity of the indices to neutron probe soil moisture measurements of

the Illinois Climate Network (ICN). The deseasoned (i.e., departures from multiyear mean annual cycle) soil moisture measurements are shown to be weakly correlated with the deseasoned full resolution ($1 \text{ km} \times 1 \text{ km}$) normalized difference vegetation index (NDVI) and fractional vegetation cover (FVC) data over both land cover types. The association, measured by the Pearson-moment-correlation coefficient, is stronger over forest than over cropland during the growing season (April-September). The correlations improve successively when the NDVI and FVC pixel data are aggregated to $3 \text{ km} \times 3 \text{ km}$, $5 \text{ km} \times 5 \text{ km}$, and $7 \text{ km} \times 7 \text{ km}$ areas. The improved correlations are partly explained by the reduction in satellite navigation errors as spatial aggregation occurs, as well as the apparent scale dependence of the NDVI-soil moisture association. Similarly, stronger relations are obtained with soil moisture data that are lagged by up to 8 weeks with respect to the vegetation indices, implying that soil moisture may be a useful predictor of warm season satellite-derived vegetation conditions. This study suggests that a "long-term" memory of several weeks is present in the near-surface hydrological characteristics, especially soil water content, of the Midwest Corn Belt. The memory is integrated into the satellite vegetation indices and may be useful for predicting crop yield estimates and surface temperature anomalies.

Document Type: Article

Source: Scopus

Giannetti, F., Montanarella, L., Salandin, R.

Integrated use of satellite images, DEMs, soil and substrate data in studying mountainous lands

(2001) *International Journal of Applied Earth Observation and Geoinformation*, 2001 (1), pp. 25-29. Cited 7 times.

Istituto Piante da Legno l'Ambiente, Corso Casale 476, Torino 10132, Italy

Abstract

A method based on the integration into a GIS of satellite images of different spatial resolution (Landsat TM and SPOT), Digital Elevation Models, geo-lithological maps and some soil-landscape data was developed and applied to a test area on a sector of the Italian northwestern Alps in the Piemonte region (Pellice, Po, Varaita and Maira valleys southwest of Torino). The main working steps performed (using GIS software) in this area were: (1) acquisition of geo-lithological and geomorphological maps available and a first definition of homogeneous zones obtained by joining different classes with pedogenic criteria; (2) processing and classification of satellite images to define homogeneous areas with reference to prevailing land cover, land use pattern, relief shape and spectral characters; (3) integration of the previous two layers to obtain a first set of cartographic units showing a distinctive and often repetitive pattern of land form, land cover and parent material; and (4) processing DEMs (slope and aspect), soil or soil-landscape data in order to refine data and characterise the units. The resulting cartographic units were superimposed on a soil-landscape map realised by means of stereoscopic interpretation of aerial photographs by IPLA at the same scale (1:250,000). This comparison was used to verify the correctness of the satellite image processing steps and consistency with the map scale used. A larger scale application was also developed for grassland at 1:50,000 scale to demonstrate the practical use of remote sensing and GIS data in assisting mountainous land development.

Author Keywords

Northwestern Alps; Satellite images; Soil; Supervised

classification; Vegetation indices

Document Type: Article

Source: Scopus

Giannetti, F.^a, Montanarella, L.^b, Salandin, R.^a

Integrated use of satellite images, DEMs, soil and substrate data in studying mountainous lands

(2001) *ITC Journal*, 3 (1), pp. 25-29. Cited 1 time.

^a Ist. Plante Legno l'Ambiente S.p.A., Corso Casale 476, 10132 Torino, Italy

^b Joint Research Centre, Space Applications Institute, European Soil Bureau, Ispra, Italy

Abstract

A method based on the integration into a GIS of satellite images of different spatial resolution (Landsat TM and SPOT), Digital Elevation Models, geo-lithological maps and some soil-landscape data was developed and applied to a test area on a sector of the Italian northwestern Alps in the Piemonte region (Pellice, Po, Varaita and Maira valleys southwest of Torino). The main working steps performed (using GIS software) in this area were: (1) acquisition of geo-lithological and geomorphological maps available and a first definition of homogeneous zones obtained by joining different classes with pedogenic criteria; (2) processing and classification of satellite images to define homogeneous areas with reference to prevailing land cover, land use pattern, relief shape and spectral characters; (3) integration of the previous two layers to obtain a first set of cartographic units showing a distinctive and often repetitive pattern of land form, land cover and parent material; and (4) processing DEMs (slope and aspect),

soil or soil-landscape data in order to refine data and characterise the units. The resulting cartographic units were superimposed on a soil-landscape map realised by means of stereoscopic interpretation of aerial photographs by IPLA at the same scale (1:250,000). This comparison was used to verify the correctness of the satellite image processing steps and consistency with the map scale used. A larger scale application was also developed for grassland at 1:50,000 scale to demonstrate the practical use of remote sensing and GIS data in assisting mountainous land development.

Author Keywords

Northwestern Alps; Satellite images; Soil; Supervised classification; Vegetation indices

Document Type: Article

Source: Scopus

Owe, M.

Estimating long term surface soil moisture from satellite microwave observations in Illinois, USA
(2001) *IAHS-AISH Publication*, (267), pp. 394-399.

MC 974, NASA/Goddard Space Flight Center, Greenbelt, MD 20771, United States

Abstract

A database of long-term soil moisture was compared to satellite microwave observations over a test site in the midwestern United States. Night-time microwave brightness temperatures were observed at a frequency of 6.6 GHz by the Scanning Multichannel Microwave Radiometer (SMMR). At 6.6 GHz, the instrument provides a spatial resolution of approximately 150 km, and a temporal frequency over the

test area of about two to three night-time orbits per week. Vegetation radiative transfer characteristics, such as the canopy transmissivity, were estimated from vegetation indices such as the NDVI and the MPDI. Because the time of satellite coverage does not always coincide with the ground measurements of soil moisture, the existing ground data were used to calibrate a water balance for the top 10 cm surface soil layer in order to interpolate daily surface moisture values. Passive microwave remote sensing presents the greatest potential for providing regular spatially representative estimates of surface soil moisture at global scales.

Author Keywords

Microwave; Optical depth; Remote sensing; SMMR; Soil moisture

Document Type: Article

Source: Scopus

Owe, M., De Jeu, R.A.M.

Retrieving surface soil moisture and vegetation optical depth from satellite microwave observations

(2001) *International Geoscience and Remote Sensing Symposium (IGARSS)*, 1, pp. 15-18.

NASA/Goddard Space Flight Center, Greenbelt, MD 20771, United States

Abstract

Soil moisture is a key component of the water and energy balance of the Earth's surface, and as such, is important to many Earth science disciplines. Soil moisture has been identified as a parameter of significant potential for improving the accuracy of large-scale land surface-atmosphere

interaction models. Because of high spatial variability, accurate estimates of surface soil moisture are often difficult to make by conventional ground measuring techniques, especially at large spatial scales. Since satellite remote sensing observations are already a spatially averaged value, they are ideally suited for measuring many land surface parameters such as soil moisture. Passive microwave remote sensing presents significant potential for providing regular spatially representative estimates of surface soil moisture at global scales. But, while the optimum wavelength for soil moisture sensing is in the L-band (1.4 GHz or $\lambda = 21$ cm), such a sensor has yet to be deployed operationally. However, new and improved microwave retrieval techniques that maximize the information that can be obtained from less optimum sensors, such as C-band and even X-band, are being developed. Progress from one such study is presented, along with preliminary results from several validation studies. It is currently planned to develop a 20+ year retrospective global database of surface soil moisture, to be made available through the Goddard Space Flight Center Distributed Active Archive Center (DAAC).

Document Type: Conference Paper

Source: Scopus

Paloscia, S.^a, Macelloni, G.^a, Santi, E.^a, Koike, T.^b

A multifrequency algorithm for the retrieval of soil moisture on a large scale using microwave data from SMMR and SSM/I satellites

(2001) *IEEE Transactions on Geoscience and Remote Sensing*, 39 (8), pp. 1655-1661. Cited 48 times.

^a Istituto di Ricerca Sulle Onde Elettromagnetiche, Consiglio

Nazionale delle Ricerche (IROE-CNR), Florence, Italy

^b Department of Civil Engineering, University of Tokyo, Tokyo, Japan

Abstract

The sensitivity of microwave emission at different frequencies to soil moisture in bare and vegetated soils has been investigated using experimental data. Since the best frequency for the measurement of soil moisture (L-band) is absent in current satellite sensors, it is necessary to seek alternative solutions. An algorithm is proposed for the retrieval of soil moisture based on the sensitivity to moisture of both the brightness temperature and the polarization index at C-band, one that is able to correct for the effect of vegetation by means of the polarization index at X-band. The algorithm has been tested by using experimental data collected with airborne microwave radiometers on agricultural areas and validated by using the data sets of special sensor microwave/imager (SMM/I) and scanning multichannel microwave radiometer (SMMR). These research activities are planned in view of coming new satellites: AQUA (NASA) and ADEOS-II (NASDA), which will be launched by the end of 2001. These will have new generation microwave radiometers (AMSR-E and AMSR) onboard, which show much better characteristics with respect to the previous sensors, in particular an enhanced spatial resolution.

Author Keywords

Hydrology; Inverse problem; Microwave radiometry; Soil moisture; Spatial heterogeneity

Document Type: Article

Source: Scopus

Owe, M., De Jeu, R., van de Griend, A.

Estimating long term surface soil moisture from satellite microwave observations in Illinois, USA

(2000) *IAHS-AISH Publication*, (267), pp. 394-399.

NASA/Goddard Space Flight Center, Greenbelt, Maryland
20771, United States

Abstract

A database of long-term soil moisture was compared to satellite microwave observations over a test site in the midwestern United States. Night-time microwave brightness temperatures were observed at a frequency of 6.6 GHz by the Scanning Multichannel Microwave Radiometer (SMMR). At 6.6 GHz, the instrument provides a spatial resolution of approximately 150 km, and a temporal frequency over the test area of about two to three night-time orbits per week. Vegetation radiative transfer characteristics, such as the canopy transmissivity, were estimated from vegetation indices such as the NDVI and the MPDI. Because the time of satellite coverage does not always coincide with the ground measurements of soil moisture, the existing ground data were used to calibrate a water balance for the top 10 cm surface soil layer in order to interpolate daily surface moisture values. Passive microwave remote sensing presents the greatest potential for providing regular spatially representative estimates of surface soil moisture at global scales.

Author Keywords

Microwave; Optical depth; Remote sensing; SMMR; Soil moisture

Document Type: Article

Source: Scopus

Sharma, R.C., Saxena, R.K., Verma, K.S.

Reconnaissance mapping and management of salt-affected soils using satellite images

(2000) *International Journal of Remote*

Sensing, 21 (17), pp. 3209-3218. Cited 5 times.

Central Soil Salinity Rsrch. Inst., Karnal-132 001, India

Abstract

The Indo-Gangetic alluvial plain is subjected to large scale soil alkalization. In order to map and characterize salt-affected soils, with the aim of applying management techniques, Etah district in Uttar Pradesh, located between 26° 45' to 28° 02' N and 78° 15' to 79° 20' E was selected. Multidate, high resolution, IRS-LISS II, geocoded FCC images on 1 : 50 000 scale were used. Integrating visual image interpretation, physiographic analysis, ground data and laboratory analysis of soil samples, a legend for mapping salt-affected soils (SAS) was formulated. Based on variations in physicochemical properties: nature, intensity and depth wise distribution of salts, five categories of SAS requiring specific reclamation measures were identified. Soil categories S2, S3 and S4 have a gypsum requirement (GR) of 20, 12 and 4t/ha-1 respectively. Reclamation of medium to heavy textured highly alkali soils requires the addition of amendments and a rice-wheat rotation for the initial 3-4 years. Under resource constraints, pit planting of *Prosopis juliflora* can bring about slow but effective reclamation. The soil category S5 is slightly alkali in the substratum, needing only biological reclamation by growing salt tolerant varieties of rice and wheat crops. Soils of category S1 are saline and need management by hydrological treatments. Incorporation of village boundaries on a map showing SAS would facilitate decision taking in

planning reclamation projects and accelerate management operations directly at village level.

Document Type: Conference Paper

Source: Scopus

Dwivedi, R.S., Sreenivas, K., Ramana, K.V.

Detecting soil information in a predominantly black soil region using Indian Remote Sensing Satellite (IRS-1B) Linear Imaging Self-scanning Sensor (LISS-II) data

(2000) *International Journal of Remote Sensing*, 21 (17), pp. 3293-3302.

National Remote Sensing Agency, Dept. of Space, Govt. of India, Balanagar, Hyderabad-500 037, India

Abstract

Spaceborne multispectral data have been operationally used for deriving information on soil resources since the early 1970s. In this study an attempt has been made to evaluate the potential of the Indian Remote Sensing Satellite (IRS-1B) Linear Imaging Self-scanning Sensor (LISS-II) data for mapping soil resources in part of northern India through a systematic monoscopic visual interpretation approach. Soils were classified up to series level. A strong correlation between the image elements and different categories of black soils has been observed, indicating thereby the potential of such data for providing reliable information on soils in the black soil region.

Document Type: Article

Source: Scopus

Dobos, E.^a , Micheli, E.^b , Baumgardner, M.F.^c , Biehl, L.^c , Helt, T.^c

Use of combined digital elevation model and satellite radiometric data for regional soil mapping

(2000) *Geoderma*, 97 (3-4), pp. 367-391. Cited 17 times.

^a Department of Geography and Environmental Sciences, University of Miskolc, 3515 Miskolc-Egyetemváros, Hungary

^b Department of Agrochemistry and Soil Science, Gödöllő Agricultural University, 2103 Gödöllő, Hungary

^c Department of Agronomy, Purdue University, West Lafayette, IN 47907, United States

Abstract

Previous reports demonstrated that data from air- and spaceborne sensors are appropriate for delineation of soil patterns. Also, many attempts have been made to use digital elevation model (DEM) for deriving soil information. However, little is known about the potential use of low spatial resolution satellite and digital elevation data in small-scale soil mapping. A case study was conducted to assess the use of integrated terrain and Advanced Very High Resolution Radiometer (AVHRR) databases for small-scale soil pattern delineation. The main objective was to test the effect of the addition of terrain descriptor data to the AVHRR data set on the classification results. Two database were used for the study. The first one was purely AVHRR data and contained the five basic AVHRR channels and the normalized difference vegetation index (NDVI) of five different dates, while in the second database the AVHRR data was complemented with a DEM, a curvature, a slope, an aspect and the potential drainage density layers. The performance of these two databases when employed to derive soil information was

compared. These databases were then further processed using the Discriminant Analysis Feature Extraction (DAFE) function (which is based on a canonical analysis procedure), and were then classified using the Fisher linear discriminant, and the ECHO spectral-spatial classifiers. Based on the results, it was concluded that the two reflective bands, the middle infrared, the two thermal bands and the NDVI provided a relatively wide range of detectable soil information. The use of single images or small dimensional AVHRR data sets (less than 10 layers) does not result in acceptable performances, while the use of multispectral and multitemporal databases improved the classification performance very significantly. However, the purely AVHRR-based model could not always delineate soil variations related to terrain differences, and resulted in an overall classification performance of 49.1%. Digital elevation and terrain descriptor data were essential in the model for achieving acceptable results. In the second part of the study an integrated AVHRR-terrain database was used, where five terrain layers were added to the 30 AVHRR channels. Two different spatial resolutions were compared, 500 m and 1 km, respectively. The use of elevation, slope, aspect and curvature as differentiating criteria often lead to a satisfactory result in terrain characterization, particularly in large-scale mapping. However, with those variables extracted from DEM of physiographically complex areas, e.g., - where plain areas and mountainous/hilly regions occur together in the same study - often lose their ability to delineate soil variations of the level lands. Beyond these terrain descriptors we implemented a new function, called potential drainage density (PDD) to improve the performance of the model on the plain areas. The classification accuracy of the integrated AVHRR-terrain database was improved significantly over the case when only AVHRR data was in the model. The classification performances of the three different resolution images were

87.3% for the 500-m resolution image and 70.1% for the 1-km resolution image. (C) 2000 Elsevier Science B.V.

Author Keywords

AVHRR; DEM; GIS; Remote sensing; Soil-landscape; Spatial modeling; Spatial variability

Document Type: Article

Source: Scopus

Caramizoiu, A., Aiftimiei, C., Stoica, A.

Soil-vegetation discrimination and assessment in satellite imagery

(2000) *Proceedings of SPIE - The International Society for Optical Engineering*, 4068, pp. 726-732.

Inst of Optoelectronics, Magurele-Bucharest, Romania

Abstract

This paper present an analysis of the remote sensing methods of extracting information on soils and land cover. For this porpoise we selected Danube Delta, a complex ecosystem, with an important role in Romanian environment and economy. Several types of satellite images were used; in order to assess their suitability in land cover and vegetation changes detection. Landsat MSS and TM, ERS1&2 images were used. Were applied contrast enhancing and special filtering procedures to improve image and remove speckle (linear, root filtering, destriping, Frost and Lee filters). At the end of this phase, we obtained good quality images with not significant information losses. On these images we performed unsupervised and supervised classifications, (vegetation classes were established during 'in situ' ground truth collection campaigns). The result of this application was the

confirmation that only combined sets of images (optical, IR and microwave) can be a useful tool for land cover assessment, vegetation and soil discrimination. Beside the multi sensor approach, another condition for a complete observation is the multitemporal approach, by using several images acquired at different intervals of time, in this way we can obtain a good vegetation discrimination on seasonal basis.

Document Type: Conference Paper

Source: Scopus

Owe, Manfred, de Jeu, Richard, Van de Griend, Adriaan
Estimates of long term surface soil moisture in the midwestern U.S. derived from satellite microwave observations

(1999) *Proceedings of SPIE - The International Society for Optical Engineering*, 3868, pp. 16-23.

NASA/Goddard Space Flight Cent, Greenbelt, United States

Abstract

A database of long-term soil moisture was compared to satellite microwave observations over a test site in the Midwestern United States. Ground measurements of average volumetric surface soil moisture in the top ten cm were made several times per month at 19 locations throughout the state of Illinois. Nighttime microwave brightness temperatures were observed at a frequency of 6.6 GHz, by the Scanning Multichannel Microwave Radiometer (SMMR), onboard the Nimbus 7 satellite. At 6.6 GHz, the instrument provides a spatial resolution of approximately 150 km, and a temporal frequency over the test area of about 3 nighttime orbits per week. Vegetation radiative transfer characteristics, such as

the canopy transmissivity, were estimated from vegetation indices such as the Normalized Difference Vegetation Index (NDVI) and the 37 GHz Microwave Polarization Difference Index (MPDI). Because the time of satellite coverage does not always coincide with the ground measurements of soil moisture, the existing ground data were used to calibrate a water balance for the top 10 cm surface layer in order to interpolate daily surface moisture values. Such a climate-based approach is often more appropriate for estimating large-area average soil moisture because meteorological data are generally more spatially representative than isolated point measurements of soil moisture. Passive microwave remote sensing presents the greatest potential for providing regular spatially representative estimates of surface soil moisture at global scales. Real time estimates should improve weather and climate modelling efforts, while the development of historical data sets will provide necessary information for simulation and validation of long-term climate and global change studies.

Document Type: Conference Paper

Source: Scopus

Toll, David L., Owe, Manfred, Foster, James, Levine, Elissa
Monitoring seasonally frozen soils using passive microwave satellite data and simulation modeling
(1999) *International Geoscience and Remote Sensing Symposium (IGARSS)*, 2, pp. 1149-1151. Cited 1 time.

NASA/Goddard Space Flight Cent, Greenbelt, United States

Abstract

Passive microwave satellite data and simulation modeling were studied to assess seasonally frozen soils for north

central U.S. and Canada. Classification of SMMR data provided an overall accuracy of 85.9% as compared to 5-cm soil temperature measurements. Preliminary work with a simulation model, FroST (Frozen Soil Temperature) indicates potential to more extensively study frozen soils.

Document Type: Conference Paper

Source: Scopus

Tansey, K.J.^a , Millington, A.C.^b , Battikhi, A.M.^c , White, K.H.^d

Monitoring soil moisture dynamics using satellite imaging radar in northeastern Jordan

(1999) *Applied Geography*, 19 (4), pp. 325-344. Cited 6 times.

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Abstract

This paper describes how synthetic aperture radar (SAR) data from the European Environmental Remote Sensing (ERS) satellite series were used to derive estimates of near-surface soil moisture for seasonally vegetated and bare soil surfaces in the area of the Jordan Badia Research and Development Programme (BRDP). Data were acquired between March 1995

and April 1998, covering both wet and dry seasons. A surface scattering model was calibrated using field data: first to understand how soil moisture affects the SAR signal and, secondly, to predict the response of the SAR signal to changes in volumetric soil moisture. Good agreement between predicted and observed estimates was obtained. Model inversion allowed soil moisture predictions to be made that were deemed realistic in terms of soil moisture values.

Author Keywords

Drylands; Jordan; Monitoring; Soil moisture; Synthetic aperture radar (SAR)

Document Type: Article

Source: Scopus

Owe, M.^{a c}, Van De Griend, A.A.^{b d}, De Jeu, R.^{b d}, De Vries, J.J.^{b d}, Seyhan, E.^{b d}, Engman, E.T.^{a c}

Estimating soil moisture from satellite microwave observations: Past and ongoing projects, and relevance to GCIP

(1999) *Journal of Geophysical Research D:*

Atmospheres, 104 (D16), pp. 19735-19742. Cited 18 times.

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^d Faculty of Earth Sciences, Vrije Universiteit Amsterdam, De Boelelaan 1085, 1081 HV Amsterdam, Netherlands

Abstract

On the basis of a series of studies conducted in Botswana and preliminary results from an ongoing study in Spain, developments in microwave remote sensing by satellite, which can be used to monitor near-real-time surface moisture and also study long-term soil moisture climatology, are described. A progression of methodologies beginning with single-polarization studies and leading to both dual polarization and multiple frequency techniques are described. Continuing analysis of a 9 year data set of satellite-derived surface moisture in Spain is ongoing. Preliminary results from this study appear to provide some evidence of long-term desertification in certain parts of this region. The methodologies developed during these investigations can be applied easily to other regions such as the GCIP area and could provide useful databases for simulation and validation studies. Additionally, they have strong potential for global applications such as climate change studies. Copyright 1999 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Hafner, J.^{a b}, Kidder, S.Q.^a

Urban heat island modeling in conjunction with satellite-derived surface/soil parameters

(1999) *Journal of Applied Meteorology*, 38 (4), pp. 448-465. Cited 29 times.

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1375, United States

Abstract

Although it has been studied for over 160 years, the urban heat island (UHI) effect is still not completely understood, yet it is increasingly important. The main purpose of this work is to improve UHI modeling by using AVHRR (Advanced Very High Resolution Radiometer) satellite data to retrieve the surface parameters (albedo, as well as soil thermal and moisture properties). In this study, a hydrostatic three-dimensional mesoscale model was used to perform the numerical modeling. The Carlson technique was applied to retrieve the thermal inertia and moisture availability using the thermal AVHRR channels 4 and 5. The net urban effect was determined as the difference between urban and nonurban simulations, in which urban parameters were replaced by rural parameters. Two winter days were each used for two numerical simulations: a control and an urban-to-rural replacement run. Moisture availability values on the less windy day showed generally a south to north gradient downwind of the city and urban values less than rural values (the urban dry island day). Moisture availability was higher on the windy day, with uniform values in the rural and urban areas (uniform soil moisture day). The only exceptions were variations in the rural hills north of the city and the low rural values under the polluted urban plume downwind of the city. While thermal inertia values showed no urban-rural differences on the uniform soil moisture day, they exhibited larger values over Atlanta than in surrounding rural area on the (less moist) dry island day. Two puzzling facts exist in the data: 1) lack of a north-south thermal inertia gradient on the dry soil day to correspond to its above-mentioned moisture availability gradient and 2) rural thermal inertia values do not change between both days in spite of their large difference in soil moisture. The observed lack of corresponding urban

change is expected, as its thermal inertia values depend more on urban building materials than on moisture of soil. In both cases both the 2-m and surface skin UHIs showed positive values at night and negative values (an urban cool island, UCI) during the day. The larger nighttime 2-m UHI was on the dry day (0.8° vs 0.6° C), while the larger daytime 2-m UCI was on the moist soil day (-0.3° vs -0.5° C). Note that the surface differences were almost always greater than the 2-m differences. These day-night differences imply a rural thermal inertia lower than its urban values on both days, which is in conflict with the observations on the wet uniform soil moisture day. On the uniform thermal inertia day (wet day), both the UHI and UCI amplitudes should be less than on the other day, but this is not the case. A possible explanation for both of these conflicts is the improper influence of the urban plume on this day on lowering the thermal inertia and moisture availability values used in the replacement urban simulation.

Document Type: Article

Source: Scopus

Vinnikov, K.Y.^{a f}, Robock, A.^{a b g}, Qiu, S.^{a f}, Entin, J.K.^{a f}, Owe, M.^{c h}, Choudhury, B.J.^{c h}, Hollinger, S.E.^{d i}, Njoku, E.G.^{e j}

Satellite remote sensing of soil moisture in Illinois, United States

(1999) *Journal of Geophysical Research D:*

Atmospheres, 104 (D4), pp. 4145-4168. Cited 55 times.

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- ^j Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, United States

Abstract

To examine the utility of using satellite passive microwave observations to measure soil moisture over large regions, we conducted a pilot study using the scanning multichannel microwave radiometer (SMMR) on Nimbus-7, which operated from 1978 to 1987, and actual in situ soil moisture observations from the state of Illinois, United States, which began in 1981. We examined SMMR midnight microwave brightness temperatures on a $0.5^{\circ} \times 0.5^{\circ}$ grid, and compared them with direct soil moisture measurements at 14 sites in Illinois for the period 1982-1987. The results suggest that both the polarization difference and the microwave emissivity for horizontal polarization at frequencies ≤ 18 GHz have real utility for use as a soil moisture information source

in regions with grass or crops where the vegetation is not too dense. While SMMR observations ended in 1987, special sensor microwave/imager observations at 19 GHz start then and extend to the present, and advanced microwave scanning radiometer instruments will fly on satellites beginning soon. Together with SMMR, they have the potential to produce a soil moisture record over large regions for more than two decades and extend it into the future. Satellite observations from these low-resolution satellite instruments measure the component of large-scale long-term soil moisture variability that is related to atmospheric forcing (from precipitation, evapotranspiration, and snowmelt). Copyright 1999 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Owe, M., Van de Griend, A.A., de Jeu, R., de Vries, J., Seyhan, E.

Satellite microwave estimates of soil moisture and their application for desertification studies

(1998) *Proceedings of SPIE - The International Society for Optical Engineering*, 3499, pp. 30-40.

NASA/Goddard Space Flight Cent, Greenbelt, United States

Abstract

Based on a series of studies conducted in Botswana and preliminary results from an ongoing study in Spain, developments in microwave remote sensing by satellite which can be used to monitor near real-time surface moisture and also study long term soil moisture climatology are described. A progression of methodologies beginning with single polarization studies and leading to both dual polarization and

multiple frequency techniques are described. Continuing analysis of a nine year data set of satellite-derived surface moisture in Spain is ongoing. Preliminary results from this study appear to provide some evidence of long term desertification in certain parts of this region. The methodologies developed during these investigations can be applied to other regions, and have the potential for providing modellers with extended data sets of independently derived surface moisture for simulation and validation studies, and climate change studies at the global scale.

Document Type: Conference Paper

Source: Scopus

Levine, Elissa, Kurz, Lubomir, Smid, Jan, Smid, Marcela, Volf, Petr

Algorithms and analysis tools for carbon content modeling in soil based on satellite data

(1998) *Proceedings of SPIE - The International Society for Optical Engineering*, 3499, pp. 315-322.

NASA/GSFC, Greenbelt, United States

Abstract

Estimate of the organic carbon content in soil is critical for global change modeling activities. Therefore, the predictive model for estimating soil carbon would provide an important tool for the scientific community. We used remotely sensed TM imaginary data together with the soil profiles and moss layer carbon data for the Northern Study Area (NSA) of the BOREAS project. Different classification and functional models of the carbon dependency on remotely sensed data were developed. The complexity of the models was scrutinized. Based on these techniques, we have developed a set of

analysis tools. These tools and an Internet based access to some of these tools will be presented.

Document Type: Conference Paper

Source: Scopus

Engman, E.T.

Development of long wave microwave satellite systems for measuring soil moisture

(1998) *Proceedings of SPIE - The International Society for Optical Engineering*, 3498, pp. 65-69.

NASA Goddard Space Flight Cent, Greenbelt, United States

Abstract

The science need for remotely sensed soil moisture has been well established in the hydrologic, climate change and weather forecasting communities. There also have been a number of programs that have demonstrated the feasibility of using long wave microwave sensors for estimating soil moisture. These have ranged from truck mounted sensors, to intensive airborne campaigns with science objectives. Based on this history of truck and aircraft experiments, the science community has settled on a soil moisture product that meets the following criteria: a two day global repeat, a measured layer of 5 cm of soil, a footprint of 20 to 30 km, and an absolute accuracy of +/- 4% volumetric soil moisture. The principal sensor to accomplish this is an L-band passive microwave radiometer. A soil moisture mission is being proposed for the NASA Earth Systems Science Pathfinder (ESSP) mission which has very real constraints of a limited budget which includes the launch vehicle, and a three year award to launch time schedule. Within the past few years there have been a number of mission concepts proposed that

meet the challenge of getting a very large antenna in space in order to realize a spatial resolution on the ground that meets the science and applications needs. This paper describes some of the alternative concepts considered to meet these unusual requirements and the ways to solve the very large antenna challenge, and the criteria used to choose the final design for an ESSP proposal. The paper also discusses the alternatives considered to obtain the necessary ancillary data for characterizing the surface roughness, the surface temperature and the attenuation affects of vegetation.

Document Type: Conference Paper

Source: Scopus

Mathieu, R.^{a b d}, Pouget, M.^a, Cervelle, B.^b, Escadafal, R.^c

Relationships between satellite-based radiometric indices simulated using laboratory reflectance data and typic soil color of an arid environment

(1998) *Remote Sensing of Environment*, 66 (1), pp. 17-28. Cited 27 times.

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Abstract

By definition, the color of an object such a soil is highly

dependent on its reflectance properties in the visible spectrum. In this study, the relationships between soil color and simulated reflectance values for the Landsat TM and SPOT HRV satellites are examined from a laboratory standpoint. Visible reflectance spectra were acquired for 124 soil samples originated from an arid environment, and selected radiometric indices were worked out for both sensors. All the earlier studies relative to soil color and remote sensing have considered the widely known Munsell method as a reference for soil color quantification. Some characteristics of this system based on a visual comparison of a soil sample with painted color chips may complicate the establishment of simple relationships between reflectance data and soil color. We have applied the CIE 1931 standard method of color measurement which consists in computing color parameters directly from reflectance spectra using colorimetric equations. Color data are expressed according to two polar coordinates called Helmholtz coordinates (dominant wavelength and purity of excitation) and luminance variable having a similar meaning to the Munsell hue, chroma, and value, respectively. The Munsell system is also employed to estimate soil color. Linear regression analysis between soil color and radiometric indices show a systematic improvement of correlations (r) from about 0.7 to more than 0.9 using Munsell data and Helmholtz data, respectively. Simple radiometric indices (band combinations) calculated from broad blue, green, and red bands are found to be good predictors of each of the soil color components. The increasing availability of spectroradiometers', including in the field, should stimulate the use of Helmholtz coordinates, as a beneficial alternative to the Munsell chart to obtain a precise and reproducible color quantification which may be useful for remote sensing applications. The radiometric indices utilized in this study are potentially helpful to contribute to soil resource and soil degradation cartography using visible

satellite data in vast arid regions where soil data are not readily available.

By definition, the color of an object such a soil is highly dependent on its reflectance properties in the visible spectrum. In this study, the relationships between soil color and simulated reflectance values for the Landsat TM and SPOT HRV satellites are examined from a laboratory standpoint. Visible reflectance spectra were acquired for 124 soil samples originated from an arid environment, and selected radiometric indices were worked out for both sensors. All the earlier studies relative to soil color and remote sensing have considered the widely known Munsell method as a reference for soil color quantification. Some characteristics of this system based on a visual comparison of a soil sample with painted color chips may complicate the establishment of simple relationships between reflectance data and soil color. We have applied the CIE 1931 standard method of color measurement which consists in computing color parameters directly from reflectance spectra using colorimetric equations. Color data are expressed according to two polar coordinates called Helmholtz coordinates (dominant wavelength and purity of excitation) and a luminance variable having a similar meaning to the Munsell hue, chroma, and value, respectively. The Munsell system is also employed to estimate soil color. Linear regression analysis between soil color and radiometric indices show a systematic improvement of correlations (r) from about 0.7 to more than 0.9 using Munsell data and Helmholtz data, respectively. Simple radiometric indices (band combinations) calculated from broad blue, green, and red bands are found to be good predictors of each of the soil color components. The increasing availability of spectroradiometers, including in the field, should stimulate the use of Helmholtz coordinates, as a beneficial alternative to the Munsell chart to obtain a precise

and reproducible color quantification which may be useful for remote sensing applications. The radiometric indices utilized in this study are potentially helpful to contribute to soil resource and soil degradation cartography using visible satellite data in vast arid regions where soil data are not readily available.

Document Type: Article

Source: Scopus

Chon, H.-T.^a , Ahn, J.-S.^a , Jung, M.C.^b

Seasonal variations and chemical forms of heavy metals in soils and dusts from the satellite cities of Seoul, Korea

(1998) *Environmental Geochemistry and Health*, 20 (2), pp. 77-86. Cited 22 times.

^a Dept. of Mineral and Petrol. Eng., College of Engineering, Seoul National University, Seoul 151-742, South Korea

^b Dept. Earth Rsrc. Environ. G., Semyung University, Jecheon 390-230, South Korea

Abstract

This research investigated heavy metal pollution of soils and dusts in two representative satellite cities of Seoul, Korea and studied the seasonal variations in metal concentrations through the rainy season and the chemical forms of metals using a sequential extraction analysis. The metal dispersion pattern was illustrated to match with urban structure. Soil and dust samples were collected from the cities of Uijeongbu and Koyang, which are the northern and northwestern satellite cities of Seoul (the capital), before and after rainy season. Concentrations of Cu, Pb and Zn were higher than

those of the world averages for soils, and their levels decreased after rain, particularly in highly contaminated samples. Relatively high pH values were found in roadside soils, but no seasonal variation was found after the rainy season. The three metals (Cu, Pb and Zn) in soils and dusts were associated with various chemical fractions of soils and dusts as distinguished by the sequential extraction scheme, and a strong similarity of metal association between soils and dusts was found, which indicates that airborne dust may be a principle source of soil contamination. Copper is uniformly distributed, and Pb is largely associated with the reducible phase. There is an appreciable proportion of total Zn in the exchangeable/water-acid soluble fraction. After the rainy season, the most soluble fractions in soils and dusts were leached away. In terms of mobility and bioavailability of metals in soils and dusts, the order $Zn \gg Cu > Pb$ is suggested. Geographical variations of total metals corresponded well with urbanised areas of cities, especially the industrial complex and major motorways.

Document Type: Article

Source: Scopus

Lakshmi, V.^{a b e}, Wood, E.F.^{a f}, Choudhury, B.J.^{a c d}

A soil-canopy-atmosphere model for use in satellite microwave remote sensing

(1997) *Journal of Geophysical Research D:*

Atmospheres, 102 (D6), pp. 6911-6927. Cited 22 times.

^a Water Resources Program, Dept. Civ. Eng. and Operations Res., Princeton University, Princeton, NJ, United States

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^f Water Resources Program, Dept. Civ. Eng. and Operations Res., Princeton University, Princeton, NJ 08544, United States

Abstract

Regional and global scale studies of land-surface-atmosphere interactions require the use of observations for calibration and validation. In situ field observations are not representative of the distributed nature of land surface characteristics, and large-scale field experiments are expensive undertakings. In light of these requirements and shortcomings, satellite observations serve our purposes adequately. The use of satellite data in land surface modeling requires developing a hydrological model with a thin upper layer to be compatible with the nature of the satellite observations and that would evaluate the soil moisture and soil temperature of a thin layer close to the surface. This paper outlines the formulation of a thin layer hydrological model for use in simulating the soil moistures and soil temperatures. This thin layer hydrological model is the first step in our attempt to use microwave brightness temperature data for regional soil moisture estimation. The hydrological model presented here has been calibrated using five years (1980-1984) of daily streamflow data for the Kings Creek catchment. The calibrated parameters are used to validate the daily streamflows for the next 5 year period (1985-1989). The comparison of surface

soil moistures and surface temperatures for the period of the Intensive Field Campaigns (IFCs) during the First ISLSCP (International Satellite Land Surface Climatology Project) Field Experiment (FIFE) in 1987 is carried out and yields good results. The thin layer hydrological model is coupled with a canopy radiative transfer model and an atmospheric attenuation model to create a coupled soil-canopy-atmosphere model in order to study the effect of the vegetation and the soil characteristics on the Special Sensor Microwave Imager (SSM/I) brightness temperatures. The sensitivities of the brightness temperatures to the soil and vegetation is examined in detail. The studies show that increasing leaf area index masks the polarization difference signal originating at the soil surface. Copyright 1997 by the American Geophysical Union.

Document Type: Article

Source: Scopus

Leone, A.P., Tedeschi, P., Wrigt, G.G., Fragnito, F.
Landsat satellite data for soil investigations in an Apennines region of southern Italy
(1997) *Geografia Fisica e Dinamica Quaternaria*, 19 (2), pp. 371-380. Cited 3 times.

Abstract

Since the launch of first earth observation satellites at the beginning of 1970s, great attention has been paid to the use of satellite remote sensing techniques in soil studies. Some investigations have studied the relationships between soil surface characteristics and soil spectral behaviour, under both laboratory and field conditions. Others have focused their attention on the image processing techniques applied to satellite and airborne scanner spectral data. This paper

presents the results of a research, using spectral information from a Landsat satellite source, for soil studies in a southern Italy Apennines region. Specifically, the objectives of the investigation were to determine the degree with which variations in soil parameters could be monitored and quantified on the basis of radiometric data gathered by the Landsat TM-5 satellite sensor. A spectral soil map has been produced over the test site. An accurate comparison between the latter and numerous available thematic maps has led to the formulation of an hypothesis about the actual and potential applications of radiometric data to soil spatial variability.

Document Type: Article

Source: Scopus

Lakshmi, V.^{a b d}, Wood, E.F.^a, Choudhury, B.J.^{a c}

Evaluation of Special Sensor Microwave/Imager satellite data for regional soil moisture estimation over the Red River basin

(1997) *Journal of Applied Meteorology*, 36 (10), pp. 1309-1328. Cited 35 times.

^a Water Resources Program, Dept. Civ. Eng. and Operations Res., Princeton University, Princeton, NJ, United States

^b General Sciences Corporation, Laboratory for Atmospheres, NASA/Goddard Space Flight Center, Greenbelt, MD, United States

^c Hydrological Sciences Branch, NASA/Goddard Space Flight Center, Greenbelt, MD, United States

^d General Sciences Corporation, Laboratory for Atmospheres, NASA/Goddard Space Flight Center, Greenbelt, MD 20771,

United States

Abstract

Regional-scale estimation of soil moisture using in situ field observations is not possible due to problems with the representativeness of the sampling and costs. Remotely sensed satellite data are helpful in this regard. Here, the simulations of 19- and 37-GHz vertical and horizontal polarization brightness temperatures and estimation of soil moistures using data from the Special Sensor Microwave/Imager (SSM/I) for 798 $0.25^\circ \times 0.25^\circ$ boxes in the southwestern plains region of the United States for the time period between 1 August 1987 and 31 July 1988 are presented. A coupled land-canopy-atmosphere model is used for simulating the brightness temperatures. The land-surface hydrology is modeled using a thin-layer hydrologic model. The canopy scattering is modeled using a radiative transfer model, and the atmospheric attenuation is characterized using an empirical model. The simulated brightness temperatures are compared with those observed by the SSM/I sensor aboard the Defense Meteorological Satellite Program satellite. The observed brightness temperatures are used to derive the soil moistures using the canopy radiative transfer and atmospheric attenuation model. The discrepancies between the SSM/I-based estimates and the simulated soil moisture are discussed. The mean monthly soil moistures estimated using the 19-GHz SSM/I brightness temperature data are interpreted along with the mean monthly leaf area index and accumulated rainfall. The soil moistures estimated using the 19-GHz SSM/I data are used in conjunction with the hydrologic model to estimate cumulative monthly evaporation. The results of the simulations hold promise for the utilization of microwave brightness temperatures in hydrologic modeling for soil moisture estimation.

Document Type: Article

Source: Scopus

Jackson, T.J.^{a b}

Soil moisture estimation using special satellite microwave/imager satellite data over a grassland region

(1997) *Water Resources Research*, 33 (6), pp. 1475-1484. Cited 59 times.

^a Agricultural Research Service, Hydrology Laboratory, U.S. Department of Agriculture, Beltsville, MD, United States

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Abstract

The special sensor microwave/imager (SSM/I) is an instrument that has been a component of several satellite platforms since 1987. Although not designed for soil moisture sensing, it is possible based on theory to extract soil moisture information under some conditions. The limiting feature of the SSM/I for soil moisture-related studies is that the frequencies are quite high and are significantly affected by vegetation. However, other features of the data, such as the frequency of measurements, are very good for observing time-varying hydrologic variables such as soil moisture. There have been no quantitative evaluations of the SSM/I using observed soil moisture data. In this study, data collected in two large-scale experiments conducted over the Little Washita watershed, in Oklahoma were available for evaluating the capabilities of SSM/I data for soil moisture mapping. Physically based models were used to relate the satellite data to the ground

observations. The results indicated that for this grass-dominated subhumid area a soil moisture-emissivity relationship with an error of estimate of 5.3% could be developed that incorporated the range of temperature and vegetation conditions encountered. An approach to adapting this approach for other vegetation regimes is still needed for wider application.

Document Type: Article

Source: Scopus

Blyth, K.

An assessment of the capabilities of the ERS satellites' active microwave instruments for monitoring soil moisture change

(1997) *Hydrology and Earth System Sciences*, 1 (1), pp. 159-174. Cited 6 times.

Institute of Hydrology, Wallingford, Oxfordshire, OX10 8BB, United Kingdom

Abstract

The launch of the European Remote sensing Satellite (ERS-1) in July 1991 represented an important turning point in the development of Earth observation as it was the first of a series of satellites which would carry high resolution active microwave (radar) sensors which could operate through the thickest cloudcover and provide continuity of data for at least a decade. This was of particular relevance to hydrological applications, such as soil moisture monitoring, which generally require frequent satellite observations to monitor changes in state. ERS-1 and its successor ERS-2 carry the active microwave instrument (AMI) which operates in 3 modes (synthetic aperture radar, wind scatterometer and

wave scatterometer) together with the radar altimeter which may all be useful for the observation of soil moisture. This paper assesses the utility of these sensors through a comprehensive review of work in this field. Two approaches to soil moisture retrieval are identified: 1) inversion modelling, where the physical effects of vegetation and soil roughness on radar backscatter are quantified through the use of multi-frequency and/or multi-polarization sensors and 2) change detection where these effects are normalized through frequent satellite observation, the residual effects being attributed to short-term changes in soil moisture. Both approaches will be better supported by the future European Envisat-1 satellite which will provide both multi-polarization SAR and low resolution products which should facilitate more frequent temporal observation.

Document Type: Article

Source: Scopus

Kammerud, T.A.^{a b}

Soil impact on satellite based vegetation monitoring in Sahelian Mali

(1996) *Geografiska Annaler, Series A: Physical Geography*, 78 (4), pp. 247-259. Cited 1 time.

^a Department of Geography, University of Oslo, Oslo, Norway

^b Department of Geography, University of Oslo, P.O. Box 1042, Blindern, N-0316 Oslo, Norway

Abstract

The use of the National Oceanic and Atmospheric Administration (NOAA) satellites, and the conventional Normalised Difference Vegetation Index (NDVI) model have

shown promise as a large scale monitoring tool to understand the vegetation dynamics of the sparsely vegetated Sahelian grasslands. One of the assumptions of the NDVI model is that the soil background is spectrally homogeneous, which is not the case. Twelve sites, within two Système Probatoire d'Observation de Terre (SPOT) satellite imageries, corresponding to NOAA Advanced Very High Resolution Radiometer (AVHRR) Local Area Coverage (LAC) pixel resolution, were assigned representative soil NDVI values for both dry and wet conditions. These soil NDVI values, together with herbaceous above-ground biomass production estimates, were used in a multiple correlation and regression analysis to assess statistically the soil impact on integrated NDVI values, i.e. values supposed only to express the total amount of vegetation in the end of the rainy season. The analysis showed that soil influence varied significantly with different soil types and moisture content, and should therefore not be ignored in satellite based vegetation monitoring.

Document Type: Article

Source: Scopus

Huete, A.R.

Extension of soil spectra to the satellite: atmosphere, geometric, and sensor considerations

(1996) *Photo Interpretation: Images Aériennes et Spatiales*, 34 (2), pp. 101-118. Cited 11 times.

University of Arizona, Tucson AZ 85721, United States

Abstract

Analyzes the relationships between field-based and space-based soil observations taking into account sensor wavebands, atmosphere, and sun-target-sensor geometric

effects. Also the use of atmospheric correction and bidirectional reflectance models in the interpretation of the satellite signal received by major space- and airborne sensor systems. Fine and coarse spectra are utilized from such sensors as the Landsat Thematic Mapper (TM) and Multispectral Scanner (MSS); Satellite pour l'Observation de la Terre (SPOT); and the aircraft-based Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) and Advanced Solid-state Array Spectroradiometer (ASAS). Future sensor systems such as SPOT-VEGETATION, Landsat 7, and the Earth Observing System (EOS) sensors are also discussed. There are abridged French and Spanish versions.

Document Type: Article

Source: Scopus

Guetter, A.K.^{a d}, Georgakakos, K.P.^{a c d}, Tsonis, A.A.^{b e}

Hydrologic applications of satellite data: 2. Flow simulation and soil water estimates

(1996) *Journal of Geophysical Research D:*

Atmospheres, 101 (21), pp. 26527-26538. Cited 9 times.

^a Hydrologic Research Center, San Diego, CA, United States

^b Department of Geosciences, University of Wisconsin, Milwaukee, WI, United States

^c Scripps Institution of Oceanography, Univ. of California at San Diego, San Diego, CA, United States

^d Hydrologic Research Center, 12780 High Bluff Drive, San Diego, CA 92130, United States

^e University of Wisconsin-Milwaukee, Department of Geosciences, Lapham Hall, P.O. Box 413, Milwaukee, WI 53201, United States

Abstract

The uncertainty in streamflow simulations and soil water estimates associated with satellite rainfall forcing is investigated for the Upper Des Moines River basin in the midwestern United States. Synthetic series of satellite rainfall estimates were produced with a rain gauge-satellite stochastic model and 10 years of daily rain gauge data (1979-1988) for three basins with drainage areas ranging from 2,000 km² to 14,000 km². The synthetic satellite rainfall series was based on observed satellite visible and infrared data which provided estimates of satellite rainfall for 180 randomly selected days in the period 1980-1987. Streamflow and soil water estimates were obtained with a rainfall-runoff-routing model (3R), based on soil water balance and accounting for snowmelt and frozen ground effects. Sensitivity of flow prediction with respect to rainfall was examined for three different conditions: (1) 3R calibrated and forced with rain gauge data, (2) 3R calibrated with rain gauge data and forced with satellite rainfall, and (3) 3R calibrated and forced with satellite rainfall. The most important results regarding the effect of satellite rainfall on flow simulation and soil water estimation for climate studies are as follows: (1) Flow simulation accuracy is sensitive to the basin scale, yielding higher correlation of simulated with observed streamflow for larger scales, (2) the hydrologic model forced with satellite data possesses skill during the period May-July for the midwestern United States, (3) derived upper soil water estimates are similar to the ones obtained using rain gauge forcing, and derived lower soil water estimates are lower than those obtained from rain gauge forcing.

Document Type: Article

Source: Scopus

Kalra, N.K.^a , Joshi, D.C.^b

Potentiality of Landsat, SPOT and IRS satellite imagery, for recognition of salt affected soils in Indian Arid Zone

(1996) *International Journal of Remote*

Sensing, 17 (15), pp. 3001-3014. Cited 8 times.

^a State Remote Sensing Applic. Centre, Jodhpur 342009, India

^b Central Arid Zone Research Institute, Jodhpur 342003, India

Abstract

Landsat, SPOT and IRS data, black and white and false colour composite (FCC) imagery of the summer (April, May), rainfed crop season (October) and winter irrigated crop season (January, February) of Indian Arid Zone were interpreted for recognition of three types of salt affected soils, viz. (1) natural salt affected; slight, moderate and severe, (2) saline soils due to saline water irrigation, (3) sodic soils due to high residual sodium carbonate (RSC) water irrigation. These were field checked and supported by analytical data. The Landsat-MSS band 4 could only provide the overall extent of salinity. The moderate and severe natural salt affected soils were identified by Landsat-MSS band 2, Landsat-MSS and TM, IRS LISS-I and LISS-II and SPOT HRV2 data for April and January. But the differentiation between the saline and sodic soils was possible only by the use of multi-date imagery (October and January) and the clue provided by the cropping pattern. The potentiality of remote sensing data products for identification of the types and degree of salt affected soils is discussed.

Document Type: Article

Source: Scopus

Jackson, Thomas J., Li, Tang Ling, Wood, Eric F., Hsu, Ann, O'Neill, Peggy E., Engman, Edwin T.

SIR-C/X-SAR as a bridge to soil moisture estimation using current and future operational satellite radars

(1996) *International Geoscience and Remote Sensing Symposium (IGARSS)*, 2, pp. 1064-1066.

USDA ARS Hydrology Lab, Beltsville, United States

Abstract

The Shuttle Imaging Radar experiments in 1994 (SIR-C/X-SAR) involved simultaneous data acquisition at a variety of frequencies and polarizations that included those of all existing and near future satellite SAR systems. As part of SIR-C/X-SAR a soil moisture experiment was conducted in the Little Washita watershed located in Oklahoma. Hydrologic conditions during the April mission started from a mostly wet soil condition with no additional rain for the duration of the mission. A data set of georegistered SIR-C and X-SAR data and ground observations has been prepared for distribution. Daily changes in incidence angle were normalized using published results for various land cover types. These normalized data were then related to soil moisture for satellite configurations representative of ERS-1 and 2, Radarsat, JERS-1, and other planned missions. Initial results show that for rangeland regions the empirical angular correction performs well and that some single frequency-polarization combinations can be used for estimating soil moisture if additional land cover/vegetation factors are considered.

Document Type: Conference Paper

Source: Scopus

Suri, M.

Satellite data - source of information on soil

(1995) *Ecology (Bratislava)*, 14 (Suppl.1), pp. 53-60.

Abstract

The objective of the paper is to present possibilities of digital processing of Landsat and Spot satellite data for obtaining information on bare soil. The emphasis has been put on spectral indices that can be correlated with several soil properties (eg colour, water and humus content) and can be also used as input parameters to various models within the geographical information systems. -from Author

Source: Scopus

Diak, G.R., Rabin, R.M., Gallo, K.P., Neale, C.M.

Regional-scale comparisons of vegetation and soil wetness with surface energy budget properties from satellite and in-situ observations

(1995) *Remote Sensing Reviews*, 12 (3-4), pp. 355-382. Cited 14 times.

Coop Inst for Met Satellite Studies, Univ of Wisconsin-Madison, 1225 West Dayton Street, Madison, WI, USA

Abstract

This study focuses on relationships between vegetation cover, soil moisture, precipitation and evapotranspiration for the Midwest and Great Plains region of the central United States in early June 1988, the year of the Midwest drought. The data base consists of: (1) microwave estimates of soil moisture made using data from the Special Sensor Microwave/Imager

(SSM/I); (2) Normalized Difference Vegetation Index (NDVI) estimates made using data from the Advanced Very High Resolution Radiometer (AVHRR); (3) surface-based Antecedent Precipitation Index (API) estimates made using precipitation records from surface reporting stations and; (4) estimates of sensible heating, evapotranspiration and an 'effective' surface roughness made for the region using a combination of satellite-measured surface 'skin' temperatures from geostationary (GOES) satellites and radiosonde measurements of the time-changes of the height of the planetary boundary layer (DH) from the synoptic network. The scatter diagram of the daytime range (time-change) of surface skin temperature (DTs) versus NDVI over the large region investigated shows a similar pattern to published results for absolute skin temperature measurements versus NDVI over smaller areas (generally the size of a single watershed). -Authors

Source: Scopus

Kolejka, J., Shallal, J.K.

Erosional hazard: quantification of soil erosion damages detected by satellite images

(1995) *Studia Geographica (Brno)*, 98, pp. 65-82.

Abstract

Laboratory soil sample data was processed to get numerical description of heavily, moderately and no erosionally damaged soils. Sample analysis results supported the TM data processing using various digital methods. A comparative evaluation of image processing methods was done.

Document Type: Article

Source: Scopus

Legrand, Michel, N'doume, Claude, Marticorena, Beatrice, Bergametti, Gilles, Callot, Yann

Soil-derived dust emission from arid areas: compared results from IR-channel satellite observation and by means of simulations

(1995) *Proceedings of SPIE - The International Society for Optical Engineering*, 2578, pp. 92-100.

Univ. des Sciences et Technologies, de Lille, Villeneuve d'Ascq cedex,, Fr

Abstract

This article deals with a comparison between dust fluxes simulated with a physical emission scheme and satellite observations of desert dust emissions. This physical scheme allows us to quantify the dust emissions as a function of the parameters describing the surface characteristics in the source-region: soil nature (size-distribution and mineralogy) and surface roughness. The surface properties of the western Sahara have been mapped on a grid (1 degree by 1 degree), using a geomorphologic approach, in order to determine the soil parameters required to perform large-scale simulations of dust emissions. The surface wind velocities are supplied by the analyses of the European Centre for Medium Range Weather Forecast (ECMWF). The western Sahara proves to be strongly non-uniform as to the threshold velocities and the related dust emissions. The spatio-temporal distributions of the emitted dust simulated by the model and the Infrared Difference Dust Index (IDDI) derived from Meteosat observations reveal a close agreement, far from being reached when using the currently used single threshold source-functions. A quantitative relation is observed for the emission strength, in the form of a linear fit between the IDDI

and the logarithm of the mass flux simulated by the dust production scheme.

Document Type: Conference Paper

Source: Scopus

Smith, S.E., Dewitt, B.A., Gonzalez, E.P., Hurt, G.W.
Georeferencing of satellite imagery for digital soil mapping

(1995) *Surveying and Land Information Systems*, 55 (1), pp. 13-20. Cited 3 times.

Univ of Florida, Gainesville, United States

Abstract

As part of a statewide effort to produce digitized soil survey maps with a satellite imagery background, Landsat Thematic Mapper imagery was georectified to the map's projection system. Provided in this paper is a description of the manner in which soil surveys are conducted by the Soil Conservation Service in Florida and the procedure being used to convert traditional soil maps to a digital form. Also described is the process by which satellite imagery can be properly georeferenced to the digital soils maps and used as a background layer in the resulting geographic information system. Due to the large size of the project - the entire state of Florida - a study of the most efficient means of rectifying the imagery that still satisfied the spatial accuracy requirements of the Soil Conservation Service was made. An accuracy and time comparison of resampling techniques is presented in the paper.

Document Type: Article

Source: Scopus

Leone, A.P., Wright, G.G., Corves, C.

The application of satellite remote sensing for soil studies in upland areas of southern Italy

(1995) *International Journal of Remote Sensing*, 16 (6), pp. 1087-1105. Cited 13 times.

CNR-Istit Studio Problm Agro Irrig, Messog, Via Cupa Patacca 85, Ercolano, NA, Italy

Abstract

This paper reports the first results of research aiming to assess the possibilities and limits of satellite remote sensing data for studying soils in the Apennine Mountains of Southern Italy. The results presented show the potential of satellite remotely-sensed data to broadly predict certain soil parameters, such as organic matter (OM) and calcium carbonate content (CACAR), from radiance values. However, the results of a sub-scene spectral classification, illustrate a greater potential for satellite data to provide useful reconnaissance soil mapping information, which can be tested by limited ground checks. -from Authors

Source: Scopus

Saha, S.K.

Assessment of regional soil moisture conditions by coupling satellite sensor data with a soil-plant system heat and moisture balance model

(1995) *International Journal of Remote Sensing*, 16 (5), pp. 973-980. Cited 6 times.

Agric. & Soils Div., Indian Inst of Remote Sensing, NRSA,

Dehradun, (U.P.), India

Abstract

Assessment of regional soil moisture conditions is important for agricultural water management, crop yield modelling and meteorological and climatic studies. This paper presents the results of an integrated remote sensing-based modelling study to estimate and map root-zone soil moisture potential, using a soil-plant system-heat and moisture balance model. The model utilizes satellite derived surface temperature, albedo, land cover and soil textural data bases and ground collected agro-meteorological data as inputs. -Author

Source: Scopus

Ahmed, N.U.

Estimating soil moisture from 6.6 GHz dual polarization, and/or satellite derived vegetation index

(1995) *International Journal of Remote Sensing*, 16 (4), pp. 687-708. Cited 33 times.

Hughes STX Corp, 7701 Greenbelt Road, \400 Greenbelt, MD, USA

Abstract

Eight and a half years (January 1979 to August 1987) of Scanning Multichannel Microwave Radiometer (SMMR) data taken at a frequency of 6.6 GHz for both day and night observations at both polarizations were processed, documented and used to study the relationship between brightness temperature (TB) and antecedent precipitation index (API) in a wide range of vegetation index (normalized difference vegetation index (NDVI) varies from 0.2 to 0.6) in the mid-west and southern United States. In general, this

study validates the model structure for soil wetness developed by Choudhury and Golus. For NDVI greater than 0.45 the resultant microwave signal is substantially affected by the vegetation. The night-time observations by both polarizations gave a better correlation between TB and API. - from Author

Source: Scopus

Sharma, K.D., Singh, S.

Satellite remote sensing for soil erosion modelling using the ANSWERS model

(1995) *Hydrological Sciences Journal*, 40 (2), pp. 259-272. Cited 2 times.

CAZRI, Jodhpur, 342003, India

Document Type: Article

Source: Scopus

van de Griend, A.A.^a, Owe, M.^b

Microwave vegetation optical depth and inverse modelling of soil emissivity using Nimbus/SMMR satellite observations

(1994) *Meteorology and Atmospheric Physics*, 54 (1-4), pp. 225-239. Cited 18 times.

^a Institute of Earth Sciences, Vrije Universiteit, de Boelelaan 1085, Amsterdam, NL-1081 HV, Netherlands

^b Hydrological Sciences Branch, NASA/GSFC, Code 974, Greenbelt, 20771, MD, United States

Abstract

A radiative transfer model has been used to determine the large scale effective 6.6 GHz and 37 GHz optical depths of the vegetation cover. Knowledge of the vegetation optical depth is important for satellite-based large scale soil moisture monitoring using microwave radiometry. The study is based on actual observed large scale surface soil moisture data and observed dual polarization 6.6 and 37 GHz Nimbus/SMMR brightness temperatures over a 3-year period. The derived optical depths have been compared with microwave polarization differences and polarization ratios in both frequencies and with Normalized Difference Vegetation Index (NDVI) values from NOAA/AVHRR. A synergistic approach to derive surface soil emissivity from satellite observed brightness temperatures by inverse modelling is described. This approach improves the relationship between satellite derived surface emissivity and large scale top soil moisture from $R^2=0.45$ (no correction for vegetation) to $R^2=0.72$ (after correction for vegetation). This study also confirms the relationship between the microwave-based MPDI and NDVI earlier described and explained in the literature. © 1994 Springer-Verlag.

Document Type: Article

Source: Scopus

Rahman, S., Vance, G.F., Munn, L.C.

Detecting salinity and soil nutrient deficiencies using SPOT satellite data

(1994) *Soil Science*, 158 (1), pp. 31-39. Cited 7 times.

Univ.WY,Dept Plant Soil & Insect Sci., Laramie,WY 82071,
United States

Document Type: Article

Source: Scopus

Cannon, M.E., McKenzie, R.C., Lachapelle, G.

Soil salinity mapping with electromagnetic induction and satellite-based navigation methods

(1994) *Canadian Journal of Soil Science*, 74 (3), pp. 335-343. Cited 26 times.

Univ.Calgary,Dept Geomat.Eng., Calgary T2N 1N4, Canada

Document Type: Article

Source: Scopus

Frederiksen, P.

Mapping and monitoring of soil degradation in semi-arid areas - satellite image methodology

(1993) *Geographica Hafniensia*, (C1), pp. 49-52.

Abstract

The aim of the study has been to investigate the possibilities for assessing and monitoring indicators of soil degradation, notably soil erosion, in a case study in Kitui District, Kenya. -
from Author

Source: Scopus

Dabrowska-Zielinska, K., Gruszczynska, M., Lewinski, S.

Soil moisture in the root zone of vegetation determined by AVHRR/NOAA satellite

(1993) *Remote sensing for monitoring the changing environment of Europe. Proc. 12th EARSeL symposium*,

Hungary, 1992, pp. 223-227.

Abstract

The paper presents the methodology for determination of soil moisture in the root zone of grassland applying NOAA/AVHRR, aerial and ground truth data. The detailed meteorological and soil moisture measurements were carried out at the area situated in the Odra River Valley (West part of Poland) during the vegetation seasons in 1990 and 1991. For soil moisture determination the ratio of sensible heat to latent heat was introduced as an indicator. Sensible heat and latent heat were determined from AVHRR/NOAA and meteorological data. - from Authors

Source: Scopus

Van De Griend, A.A., Owe, M.

Determination of microwave vegetation optical depth and single scattering albedo from large scale soil moisture and Nimbus/SMMR satellite observations

(1993) *International Journal of Remote Sensing*, 14 (10), pp. 1875-1886. Cited 19 times.

Institute of Earth Sciences, Vrije Universiteit, de Boelelaan 1085, 1081 HV Amsterdam, The Netherlands

Abstract

The single scattering albedo and optical depth of typical savanna vegetation in Botswana (Africa) have been determined by inverse modelling using satellite observed microwave signatures and surface soil moisture. Soil emissivity was modelled using a multi-layer radiative transfer model. The study is based on large scale surface moisture data and Nimbus/SMMR 6.6 GHz and 37 GHz dual polarized

brightness temperatures over a 3-year period. As compared to the optical depths, the derived single scattering albedos displayed only minor seasonal variations, whereas the values fit well within the range reported in the literature from laboratory and field experiments. Both 6.6 and 37 GHz optical depths were found to be significantly related to NDVI-values derived from NOAA/AVHRR. -Authors

Source: Scopus

Teng, W.L., Wang, J.R., Doraiswamy, P.C.

Relationship between satellite microwave radiometric data, antecedent precipitation index, and regional soil moisture

(1993) *International Journal of Remote Sensing*, 14 (13), pp. 2483-2500. Cited 31 times.

Hughes STX Corporation, 4400 Forbes Boulevard, Lanham, Maryland 20706, USA.

Abstract

Satellite microwave brightness temperatures (TB's) have been shown, in previous studies for semi-arid environments, to correlate well with the antecedent precipitation index (API), a soil moisture indicator. The current study, using the Special Sensor Microwave/Imager (SSM/I), continued this work for parts of the US Corn and Wheat Belts, which included areas with a more humid climate, a denser natural vegetation cover, and a different mix of agricultural crop types. Correlation results between TB at 19 GHz and API were highly dependent on geographical location. Correlation coefficients (r values) ranged from -0.6 to -0.85 for the semi-arid parts of the study area and from -0.3 to -0.7 for the more humid and more densely vegetated parts. R values were also higher for

the very dry and very wet years (-0.5 to -0.85) than for the "normal" year (-0.3 to -0.65). Similar to previous results, the Microwave Polarization Difference Index (MPDI), based on the 37 GHz data, was found to correspond to variations in vegetation cover. The MPDI was used to develop a linear regression model to estimate API from TB. -from Authors

Source: Scopus

Nakaegawa, T., Fuchigami, G., Koike, M., Oki, T., Musiake, K.
Extraction of soil moisture information from SAR satellite data

(1993) *International Geoscience and Remote Sensing Symposium (IGARSS)*, 4, pp. 1797-1799. Cited 2 times.

Univ of Tokyo, Tokyo, Japan

Abstract

Relating to the global climate change prediction, hydrologists are interested in large-scale hydrological processes, particularly in evapotranspiration process as an interaction between land surface and atmosphere. Soil moisture is an important factor controlling the evapotranspiration process. SAR data of E ERS-1 and J ERS-1 are expected to provide large-scale soil moisture information which can be incorporated into a macro-hydrological modelling. However, radar backscatter is sensitive not only to soil moisture but also to surface conditions and soil characteristics. Authors are carrying out ERS-1s' simultaneous verification experiments at five sites with different surface-soil conditions, to establish the relationship between radar backscatter and soil moisture. Experiments include direct sampling of surface soil, measurement of backscatter using C-band scatterometer mounted on an automobile and field dielectric measurements

using potable C and L band dielectric probe. Experiments and their analysis are still going on. In this paper, some preliminary result are reported.

Document Type: Conference Paper

Source: Scopus

Kondrat'ev, K.Y., Vandysheva, N.V., Kozoderov, V.V., Kosolapov, V.S.

Estimation of parameters of the soil and vegetation from multispectral satellite data

(1993) *Soviet Journal of Remote Sensing*, 10 (3), pp. 507-518.

Abstract

In the context of the development of methods for estimating parameters of the state of the soil/vegetation system from space, the paper discusses the characteristics of the use of an atmospheric correction procedure in thematic interpretation of remote-sensing data. The accuracy with which the phytomass of vegetation is recovered from multispectral satellite images is estimated. -from Authors

Source: Scopus

Peck, E.L., Carroll, T.R., Lipinski, D.M.

Airborne soil moisture measurements for First International Satellite Land Surface Climatology Program Field Experiment

(1992) *Journal of Geophysical Research*, 97 (D17), pp. 18,961-18,967. Cited 5 times.

Abstract

The airborne gamma radiation system of the National Weather Service (NWS) was used to measure soil moisture over a research area near Manhattan, Kansas, in 1987 and in 1989. A large number of ground soil moisture measurements were collected for calibration of the flight lines. The NWS standard operational method to obtain soil moisture estimates for flight lines that average 16 km in length, using three airborne measurements of gamma radiation fluxes, was adapted for use with the shorter flight lines. Examples of temporal and spatial variations of soil moisture for the research area are presented. -from Authors

Source: Scopus

Jurgens, C., Fander, M.

Soil erosion assessment and simulation by means of satellite remote sensing and ancillary digital data

(1992) *Geo-Information-Systeme*, 5 (4), pp. 27-31.

Abstract

This study uses the well-known Universal Soil Loss Equation (USLE) and satellite remote sensing data to assess the long-term soil erosion in a small catchment area and to simulate various soil protection alternatives by assistance of a GIS. - Authors

Source: Scopus

Agbu, P.A., Olson, K.R.

Model to predict soil parent material underlying a loess mantle in Illinois from satellite data

(1992) *Soil Science*, 153 (2), pp. 142-148. Cited 1 time.

NASA/Goddard Space Flight Center, Greenbelt, MD 20771,
USA

Abstract

Soils were sampled on two regular grids, each covering an area of 3108 ha, in Ford County, Illinois. The soils developed in thin loess over both loamy and clayey glacial till, outwash, and lacustrine sediments of the Wisconsin glaciation. Satellite spectral data were statistically analyzed by multiple-regression procedure to develop a model (linear equation) to predict underlying soil parent material with a thin loess mantle. The absence of loess mantle at some of the undulating reference sites due to erosion and the presence of a new parent material underlying the loess mantle at the test site contributed to the differences between predicted and observed underlying parent materials. The possibility for reasonable subdivision of an image suggests a potential for improving spectral soil maps by separation of large survey areas with thin loess mantles by underlying parent materials prior to computer classification. -from Authors

Source: Scopus

Price, K.P., Ridd, M.K.

Detection of soil erosion within pinyon-juniper woodlands using Thematic Mapper (TM) satellite data
(1991) *Technical papers ACSM-ASPRS annual convention, Baltimore, 1991. Vol. 3: remote sensing*, pp. 319-328.

Department of Geography, University of Kansas, Lawrence,
KS 66045- 2121, USA

Abstract

Pinyon and juniper (*Pinus* spp. and *Juniperus* spp.) woodlands

cover approximately 24.3 million hectares in the western United States. It is estimated that 50% of the lands they now occupy have been invaded by these trees in the last 125 years. Studies indicate that soil erosion is accelerated after tree invasion. The objective of this study was to test the sensitivity of Landsat Thematic Mapper (TM) data for detecting soil erosion within pinyon-juniper woodlands. A secondary objective was to assess the potential of the spectral data for assigning the Universal Soil Loss Equation (USLE) Crop Management (C) factor to varying cover types within the woodlands. -from Authors

Source: Scopus

Baban, S.M.J.

The derivations of hydrological variables (including soil moisture) from satellite imagery. Ph.D. thesis

(1991) 401 p.

Abstract

The applicability of remote sensing techniques in various aspects of hydrology was examined, employing Landsat imagery and microcomputers. Image processing techniques and data modelling used new and established algorithms to relate Landsat imagery to ground referenced variables. To allow future portability much of the work was done on a PC using the standard PCIPS package. Methods available were reviewed, the following fields were included in the study: 1) Detecting water depth. 2) Detection and interpretation of water surface temperature and circulation employing thermal (TM6) and reflective (TM1) bands in three lakes. 3) Detection and interpretation of water quality parameters in lakes. 4) Establishing trophic classifications for lakes. 5) Classification and water quality parameter detection in an estuarine

environment. 6) Landcover classification and the detection of soil moisture levels. Practical cost-effective applications for all of these fields have been suggested. -from Author

Source: Scopus

Bastiaanssen, W.G.M.

Derivation of areal soil physical data from satellite measurements

(1991) *Hydrological interactions between atmosphere, soil and vegetation. Proc. symposium, Vienna, 1991*, pp. 95-105. Cited 1 time.

The Winand Staring Centre for Integrated Land, Soil and Water Res, PO Box 125, 6700 AC Wageningen, The Netherlands

Abstract

Nowadays, the interrelation between hydrology and climate change is a debated issue. A better description of the heterogeneity of soil physical properties is recognized as being a crucial element in the improvement of simulating the hydrological cycle with Global Circulation Models (GCMs). A method based on Landsat-Thematic Mapper measurements of surface temperature, T_0 , and surface albedo, r_0 , has been developed to derive effective resistances for the transport of water and heat in a two-layer soil heat balance model. -from Author

Source: Scopus

Price, Kevin P., Ridd, Merril K.

Detection of soil erosion within Pinyon-Juniper

woodlands using thematic mapper (TM) satellite data

(1991) *Technical Papers - ACSM-ASPRS Annual Convention*, 3, pp. 319-328.

Abstract

The objective of this study was to test the sensitivity of Landsat Thematic Mapper (TM) data for detecting soil erosion within pinyon-juniper woodlands. A secondary objective was to assess the potential of the spectral data for assigning the Universal Soil Loss Equation (USLE) Crop Management (C) factor to varying cover types within the woodlands. Results show greatly accelerated rates of soil erosion on pinyon-juniper sites. Percent cover by pinyon-juniper, total soil-loss and total nonliving ground cover accounted for nearly 70% of the variability in TM channels 2, 3, 4 and 5. TM spectral data were consistently better predictors of soil erosion than the biotic and abiotic field variables. Satellite data were more sensitive to vegetation variation than the USLE C factor and USLE is a poor predictor of soil loss on pinyon-juniper sites. A new string-to-ground soil erosion prediction technique is introduced. New soil erosion models should be developed that incorporate satellite remotely sensed data.

Document Type: Conference Paper

Source: Scopus

Bastiaanssen, W.G.M.

Derivation of areal soil physical data from satellite measurements

(1991) *IAHS Publication (International Association of Hydrological Sciences)*, (204), pp. 95-105.

Winand Staring Cent for Integrated, Land, Soil and Water Research, Wageningen, Netherlands

Abstract

Nowadays, the interrelation between hydrology and climate change is a debated issue. A better description of the heterogeneity of soil physical properties is recognized as being a crucial element in the improvement of simulating the hydrological cycle with Global Circulation Models (GCMs). A method based on Landsat-Thematic Mapper measurements of surface temperature, T_0 , and surface albedo, r_0 , has been developed to derive effective resistances for the transport of water and heat in a two-layer soil heat balance model. The method only holds when a fraction of the area under consideration is covered by non-evaporative land surfaces. For a regional scale equivalent with the scale of a GCM grid cell ($100 \times 100 \text{ km}^2$), the method showed for the Western Desert in Egypt at the moment of satellite overpass the following: an effective soil resistance to heat transfer of $0.41 \text{ W}^{-1} \cdot \text{m}^2 \cdot \text{K}$, to vapour transfer of $409 \text{ s} \cdot \text{m}^{-1}$ and to liquid transfer of $29 \times 10^6 \text{ s} \cdot \text{m}^{-1}$. The effective aerodynamic resistance to heat transfer was determined to be $46 \text{ s} \cdot \text{m}^{-1}$. If radar techniques will be further developed to measure the depth of the evaporation front independently from the $T_0 = f(r_0)$ relationship, estimated soil resistances can turn into effective diffusivity values.

Document Type: Conference Paper

Source: Scopus

Agbu, P.A., Fehrenbacher, D.J., Jansen, I.J.

Soil property relationships with SPOT satellite digital data in east central Illinois

(1990) *Soil Science Society of America*

Journal, 54 (3), pp. 807-812. Cited 10 times.

Abstract

The second-generation remote sensing satellites with improved spatial and spectral resolution offer additional possibilities for conducting soil surveys. This study was undertaken to determine the relationships that exist among high-resolution satellite digital data and soil properties useful in map-unit delineation and classification. A second objective was to develop models (linear equations) based on soil properties to predict satellite spectral response. The results showed that most surface soil properties and some subsurface properties pertinent to soil classification and map-unit separation can be used to predict satellite data and vice versa. -from Authors

Source: Scopus

O'Neill, A.L., Eldridge, D.J.

Satellite monitoring of soils, vegetation and grazing impacts in the semi-arid region of western New South Wales

(1990) *Australian ecosystems. Proc. symposium, Geraldton, W.A., 1988*, pp. 441-447. Cited 1 time.

Geography Department, University of Wollongong, PO Box 1144, Wollongong, NSW 2500, Australia

Abstract

Satellite remote sensing provides a relatively rapid and cost effective means of mapping the physical and biological resources of large areas. Landsat Multispectral Scanner digital imagery was used to map soils, vegetation and erosion in a semi-arid area of south-western New South Wales. The classified image showed strong agreement with independently mapped soil boundaries. The technique developed is suitable

for identifying and mapping areas affected by fire, overgrazing, erosion, land clearing and cultivation. With an increased awareness of ecologically-based landuse practices, the use of remote sensing for monitoring changes in land use and land degradation is likely to increase. -Authors

Source: Scopus

Haiping Su, Ransom, M.D., Kanemasu, E.T.

Detecting soil information on a native prairie using Landsat TM and SPOT satellite data

(1989) *Soil Science Society of America Journal*, 53 (5), pp. 1479-1483. Cited 7 times.

Second author address: Throckmorton Hall, Kansas State Univ., Manhattan, KS 66506, USA

Abstract

Computer pattern recognition techniques were used to discriminate soil information from the Landsat Thematic Mapper (TM) and the French Systeme Probatoire d'Observation de la Terre (SPOT) satellite data on a native prairie near Manhattan, KS. Digital Elevation Model (DEM) data were merged to Landsat TM and SPOT data to delineate soil mapping units within the study area. Soil mapping units from a conventional soil survey were compared with a classified soil spectral map obtained from Landsat TM or SPOT, and DEM derived elevation, slope, and aspect data, using an overall accuracy assessment. The overall accuracy of soil spectral classes from TM and SPOT data was improved after DEM data were merged. Our results indicate that high resolution Landsat TM and SPOT satellite data can be used to aid second-order soil surveys in areas where the dominant land use is rangeland. -from Authors

Source: Scopus

Nemani, R.R., Running, S.W.

Testing a theoretical climate-soil-leaf area hydrologic equilibrium of forests using satellite data and ecosystem simulation

(1989) *Agricultural and Forest Meteorology*, 44 (3-4), pp. 245-260. Cited 91 times.

School of Forestry, University of Montana, Missoula, MT 59812, United States

Abstract

We hypothesize that a necessary equilibrium exists between climate, soil water-holding capacity and maximum leaf area in water limited coniferous forest ecosystems. To test this hypothesis over a large range of forests in Montana, spectral reflectance data from two different satellite sensors, Landsat/Thematic Mapper and NOAA/AVHRR, were combined with leaf area index (LAI) measured or simulated from a forest ecosystem model, FOREST-BGC. Transpiration simulated by the model with representative climatic and soil data was used to calculate equilibrium leaf area index of 20 mature conifer forest stands across Montana. A strong correlation was found between calculated and field measured of leaf area index, $R^2 = 0.87$. To test if satellite data can estimate LAI, measured leaf area index was correlated with spectral reflectance data from TM computed as the Normalized Difference Vegetation Index (NDVI) for 17 stands ($R^2 = 0.58$). Then, LAI for 53 conifer stands across Montana was estimated using our equilibrium concept and related to AVHRR/NDVI at 1.1 km scale ($R^2 = 0.88$). Species composition was found to be important only at the TM pixel

scale of 30 m. AVHRR/NDVI provided an initial validation of our hydrologic equilibrium theory at regional scales. A quantitative relationship between climate defined simply as precipitation/potential evaporation, soil water-holding capacity and leaf area was developed using the model simulations. This relationship allows the prediction of either equilibrium leaf area index or soil water-holding capacity if the other is known. © 1989.

Document Type: Article

Source: Scopus

Frederiksen, P.

Soils of Tierra del Fuego: a satellite-based land survey approach

(1988) *Folia Geographica Danica*, 18, 159 p. Cited 9 times.

Abstract

Tierra del Fuego consists of perhumid zones rounded by an icesheet, humid alpine and subalpine zones overdeepened by outlet glaciers, subhumid to semiarid lowlands formed by outlet glaciers, subhumid highlands covered by a local ice cap, semiarid highlands formed by outlet glaciers and non-glaciated hills (around Rio Grande). In the lowlands 5 glacial stages are recognized. -from Author

Source: Scopus

Wright, G.G., Morrice, J.G.

Potato crop distribution and subdivision on soil type and potential water deficit: an integration of satellite imagery and environmental spatial database

(1988) *International Journal of Remote*

Sensing, 9 (4), pp. 683-699.

Remote Sensing Unit, Dept of Peat & Forest Soils, The
Macaulay Land Use Research Inst., Craigiebuckler, Aberdeen,
AB9 2QJ, UK

Abstract

Using multitemporal Landsat satellite radiance values the distribution and area of the potato crop within the Kincardine and Deeside District of Grampian Region is presented. The spatial distribution database is integrated with soil and potential water deficit data to generate statistical information on the proportion of the potato crop growing on drought susceptible soils. -from Authors

Source: Scopus

Choudhury, B.J., Golus, R.E.

Estimating soil wetness using satellite data

(1988) *International Journal of Remote Sensing*, 9 (7), pp. 1251-1257. Cited 31 times.

Hydrol Sci Branch, NASA Goddard Space Flight Center,
Greenbelt, MD 20771, USA

Abstract

Improved estimates of soil wetness were obtained using observations from both the NIMBUS-7 Scanning Multichannel Microwave Radiometer (SMMR) and the NOAA-7 Advanced Very High Resolution Radiometer (AVHRR), from which a vegetation index was derived. The model was found to be useful in describing four levels of soil wetness as compared to three levels when vegetation was not considered. -Authors

Source: Scopus

Sharma, R.C., Bhargava, G.P.

Assessment and monitoring of alkali soils in Haryana, India, using satellite imagery

(1988) *Soil Survey & Land Evaluation*, 8 (2), pp. 86-93. Cited 1 time.

Central Soil Salinity Res Inst, Karnal-132001 Haryana, India

Abstract

Visual interpretation of single band or false colour composite Landsat imagery was found effective in mapping alkali soils and monitoring progress of their reclamation. Using different seasons and bands, it was found that data from May and November, particularly of band 5 of Landsat-1 and band 2 of Landsat-4 gave the greatest information. While the 1:1 million scale imagery enabled the identification of alkali areas, the 1:250 000 scale was used in demarcating and estimating the areal extent. The study area comprised 200 000 has of which 32 000 ha (16%) was mapped as alkali affected. Comparison of imagery from the years 1975 and 1984 showed a considerable shrinkage in alkali-affected area, as only 15 810 ha remained unreclaimed in 1984. The reclaimed alkali soils showed significant improvement in soil properties and also produced good yields of rice and wheat in the first and subsequent years of reclamation. -Authors

Source: Scopus

Owe, M.^a, Chang, A.^a, Golus, R.E.^b

Estimating surface soil moisture from satellite microwave measurements and a satellite derived

vegetation index

(1988) *Remote Sensing of Environment*, 24 (2), pp. 331-345. Cited 22 times.

^a Hydrological Sciences Branch, Laboratory for Terrestrial Physics, NASA /Goddard Space Flight Center, Greenbelt, MD 20771, United States

^b Science Applications Research, 4400 Forbes Boulevard, Lanham, MD 20706, United States

Abstract

Normalized 18 GHz microwave brightness temperatures (TB) and a vegetation index were calculated from satellite radiometer data, and subsequently used in conjunction with climatically modeled surface moisture estimates to calibrate a simple physically based soil moisture model. Test sites within the U.S. Southern Great Plains were chosen for their range of climatic conditions from east to west. Normalized TB values correlated well with soil moisture when the data were segregated by vegetation index range, but less so when all data were combined. With the introduction of a vegetation index parameter, the model accounted for approximately 70% of the variability in modeled surface soil moisture. The model was validated with data from three separate test sites, with predicted moisture again accounting for 70% of the variability in the modeled surface moisture. The approach appears to be valid, at least for areas of arid or semiarid climatic conditions. These results are more encouraging than previous truck- or aircraft-mounted radiometers of similar frequency have indicated. © 1988.

Document Type: Article

Source: Scopus

Petersen, G.W., Connors, K.F., Miller, D.A., Day, R.L., Gardner, T.W.

Aircraft and satellite remote sensing of desert soils and landscapes

(1987) *Remote Sensing of Environment*, 23 (2), pp. 253-271. Cited 2 times.

Penn State University, University Park, PA 16802, United States

Abstract

The remote sensing of desert soils and landscapes using Thematic Mapper (TM), Heat Capacity Mapping Mission (HCMM), Simulated SPOT, and Thermal Infrared Multispectral Scanner (TIMS) data is discussed. These studies were all conducted in arid or semiarid study sites. Landsat Thematic Mapper (TM) data for southwestern Nevada discriminated among alluvial fan deposits with different degrees of desert pavement and varnish as well as different vegetation cover. Thermal-infrared data acquired from the Heat Capacity Mapping Mission (HCMM) satellite were used to map the spatial distribution of diurnal surface temperatures and to estimate mean annual soil temperatures in semiarid east central Utah using diurnal data for five dates throughout a year. Simulated SPOT data for northwestern New Mexico identified geomorphic features, such as differences in eolian sand cover and fluvial incision, which are correlated with surface age and geomorphic stability of landscape components. The Thermal Infrared Multispectral Scanner (TIMS), which is an aircraft scanner that provides six-channel spectral capability in the thermal region of the electromagnetic spectrum, was used to depict surface geologic features of the Saline Valley in southeastern California. These research projects are presented as a

summary of some of the sensors and analytical techniques that are useful in the study of desert soils and landscapes. © 1987.

Document Type: Article

Source: Scopus

Biswas, R.R.

A soil map through Landsat satellite imagery in a part of the Auranga catchment in the Ranchi and Palamou districts of Bihar, India.

(1987) *International Journal of Remote Sensing*, 8 (4), pp. 541-543. Cited 4 times.

All India Soil and Land Use Survey Organisation, Dept of Agric and Cooperation, 207 NSC Bose Rd, Calcutta 40, India.

Abstract

An attempt has been made to explore various geomorphic units and their related soils in association of series level found to occur in the area with a map. -Author

Source: Scopus

Wright, G.G., Birnie, R.V.

Detection of surface soil variation using high resolution satellite data: results from the UK SPOT-simulation investigation.

(1986) *International Journal of Remote Sensing*, 7 (6), pp. 757-766. Cited 4 times.

Dept of Peat & Forest Soils, The Macaulay Inst for Soil Research, Craigiebuckler, Aberdeen, AB9 2QJ, Scotland, UK.

Abstract

A problem in using multispectral scanner (MSS) data for soil and land-system analysis in north-west Europe is the poor spatial resolution which is insufficient to provide adequate within-field data. The SPOT satellite system will provide MSS data at 20 m resolution and panchromatic data at 10 m resolution. For any given ground feature the SPOT MSS mode will provide considerably more sample areas than Landsat 80 m data. The object of this study is to determine how far variation in surface soil parameters can be detected and quantified on the basis of SPOT data. -Authors

Source: Scopus

Bernard, R., Taconet, O., Vidal-Madjar, D.

TOWARD A SATELLITE SYSTEM TO MONITOR THE SPATIAL AND TEMPORAL BEHAVIOUR OF THE SOIL WATER CONTENT.

(1986) *Digest - International Geoscience and Remote Sensing Symposium (IGARSS)*, pp. 751-753. Cited 1 time.

CNET/CRPE, Issy-les-Moulineaux, Fr, CNET/CRPE, Issy-les-Moulineaux, Fr

Abstract

A good knowledge of the soil water content, especially in the root zone, and of its variations during the pregrowing and the growing seasons is valuable for climate and hydrology studies as well as for yield prediction or agricultural work planning. In the past ten years, the possibility to obtain this parameter has been demonstrated in a large-scale basis from space. It has lead to the definition of a satellite system which could be used in that field. The concept of such a system is described.

It is shown that algorithms using satellite or airborne sensors data (visible, thermal infrared and microwave) are readily available for nearly operational use.

Document Type: Conference Paper

Source: Scopus

Fujita, Masaharu, Ulaby, Fawwaz T.

PERFORMANCE EVALUATION OF A SATELLITE-BORNE SYNTHETIC APERTURE RADAR FOR SOIL MOISTURE MAPPING BY A COMPUTER SIMULATION TECHNIQUE.

(1986) *Journal of the Radio Research Laboratory*, 33 (138), pp. 27-42.

Abstract

The ability of a satellite-borne synthetic aperture radar (SAR) to detect soil moisture is evaluated by means of a computer simulation technique. The computer simulation package includes the azimuth compression processing using a range-sequential processor. The results of computer simulations indicate that in estimating soil moisture content with a four-look processor, the difference between the assumed and estimated values of soil moisture is within plus or minus 20% of field capacity for 57% of the pixels for an agricultural flood-plain and for 50% of the pixels for a hilly terrain. The estimation accuracy for soil moisture may be improved by reducing the effect of fading by noncoherent averaging.

Document Type: Article

Source: Scopus

Lynn, D.W.

Monotemporal, multitemporal, and multirate thermal

infrared data acquisition from satellites for soil and surface-material survey.

(1986) *International Journal of Remote Sensing*, 7 (2), pp. 213-231.

Dept of Geog, Univ of Reading, Reading, RG6 2AB, UK.

Abstract

With the improvement in spatial resolution of thermal sensors over the past decade the employment of thermal infrared satellite data for soil and surface-material survey has become increasingly attractive. The individual orbital characteristics of each satellite provide the opportunity of acquiring monotemporal (same day, one time), multitemporal (same day, different times) and multirate (different days, same time) imagery. The time at which such imagery is acquired is of great importance since the emitted thermal response of any natural material is a function not only of the material's emissivity, but also of its temperature at the time of imaging. The implications of acquiring monotemporal, multitemporal and multirate thermal infrared data are discussed in relation to thermal sensors in past, current and future satellites.-

Author

Source: Scopus

Traebert, E., Blanke, J.H., Hucke, R., Heckmann, P.H.
SATELLITE LINES IN THE EUV SPECTRUM OF SOIL-EXCITED LITHIUM.

(1985) *Physica Scripta*, 31 (2), pp. 130-136. Cited 1 time.

Ruhr-Univ Bochum, Bochum, West Ger, Ruhr-Univ Bochum, Bochum, West Ger

Abstract

The EUV spectrum of lithium in the wavelength range 10-28 nm has been recorded with high spectral resolution. About one hundred lines of Li III, singly and doubly excited Li II and doubly excited Li I have been identified. The line-rich spectrum obtained after foil excitation is contrasted with the spectrum obtained after He gas excitation of Li** plus ions. The lifetimes of three core-excited states have been determined and found to agree with theoretical predictions.

Document Type: Article

Source: Scopus

Rao, K.S., Venkatachalam, P., Sowmya, A., Kandya, A.K., Majumdar, T.J.

Capability of Bhaskara-II satellite microwave radiometer brightness temperature data to discriminate soil moisture conditions of Indian landmass.

(1984) *Remote sensing from satellites*, pp. 91-96.

Centre of Studies in Resources Eng, IIT, Bombay, India.

Abstract

With the objective of developing microwave remote sensing technology in the country, India has launched a series of satellites Bhaskara-I and II with the microwave radiometer capability. In this paper, an attempt is made to demonstrate the capability of the brightness temperature data acquired by these radiometers to discriminate various soil conditions of the Indian land mass. The analysis show that large areas assessment of soil moisture is possible to a limited extent. -
Authors

Source: Scopus

Rao, K.S.^a , Venkatachalam, P.^a , Sowmya, A.^a , Kandya, A.K.^b , Majumdar, T.J.^b

Capability of Bhaskara-II satellite microwave radiometer brightness temperature data to discriminate soil moisture conditions of Indian landmass

(1984) *Advances in Space Research*, 4 (11), pp. 91-96.

^a Centre of Studies in Resources Engineering, IIT, Bombay, India

^b Indian Space Research Organisation, SAC, Ahmedabad, India

Abstract

With the objective of developing Microwave Remote Sensing technology in the country, India has launched a series of Satellites Bhaskara-I and II with the microwave radiometer capability. In this paper, an attempt is made to demonstrate the capability of the brightness temperature data acquired by these radiometers to discriminate various soil moisture conditions of Indian land mass. The analysis show that large areas assessment of soil moisture is possible to a limited extent. © 1985.

Document Type: Article

Source: Scopus

Raffy, M., Busquet, C., Becker, F.

CONTRIBUTION TO THE EVALUATION OF SOIL CHARACTERISTICS USING SATELLITE DATA.

(1984) *Proceedings of the International Symposium on Remote Sensing of Environment*, 2, pp. 1065-1073.

GSTS, Strasbourg, Fr, GSTS, Strasbourg, Fr

Abstract

We propose two general methods in order to obtain agrometeorological and geological parameters such as thermal inertia and evapotranspiration flux over large regions of our planet from both visible and thermal infrared data obtained from satellites.

Document Type: Conference Paper

Source: Scopus

Wetzel, P.J., Atlas, D., Woodward, R.H.

Determining soil moisture from geosynchronous satellite infrared data: a feasibility study.

(1984) *Journal of Climate & Applied Meteorology*, 23 (3), pp. 375-391. Cited 39 times.

NASA/Goddard Lab for Atmos Sciences, Greenbelt, MD 20771, USA.

Abstract

In the absence of a current capability for global routine daily soil moisture observation, an infrared technique using existing instrumentation is sought. In order to determine which physical parameters observable from GOES are most sensitive to soil moisture and which are less prone to interference by seasonal changes, atmospheric effects, vegetation cover, etc, a detailed one-dimensional boundary layer-surface-soil model was employed. A series of model runs were then used to develop a simulated surface temperature dataset from which

a soil moisture algorithm was developed. This algorithm uses only GOES observations to separate the soil moisture signal from the interfering effects on the surface temperature.-from Authors

Source: Scopus

Lynn, D.W.

Satellite thermal data for soil and surface material survey - time for change?

(1984) *Satellite remote sensing. Proc. 10th anniversary conference, Reading, 1984, (Remote Sensing Society, University of Reading)*, pp. 41-52.

Dept Geog, Univ of Reading, Whiteknights, Reading RG6 2AB, UK.

Abstract

With the improvement in spatial resolution of thermal sensors over the past decade employment of thermal satellite data for soil and surface material survey has become increasingly attractive. The individual orbital characteristics of each satellite provide the opportunity of acquiring multirate and often multitemporal imagery. The time at which such imagery is acquired is of great importance since the emitted response of a material is not only a function of the material's emissivity, but also its temperature at the time of imaging. The implications of multitemporal and multirate data acquisition from present satellites are discussed. -Author

Source: Scopus

Lamont, J.M., Quegan, S.

The applicability of radar image models to satellite monitoring of soils, agriculture and forestry.

(1984) *Satellite remote sensing. Proc. 10th anniversary conference, Reading, 1984, (Remote Sensing Society, University of Reading)*, pp. 375-382.

GEC, Marconi Res Centre, West Hanningfield Road, Gt. Baddow, Chelmsford, Essex CM2 8HN, UK.

Abstract

The power backscattered from natural targets is influenced by both target and system dependent features. The target dependence includes soil dielectric, roughness and slope, plant dielectric, height, density, row direction and geometry. System dependence includes, frequency, look angle and direction, polarisation and resolution. A review is given of models which attempt to simulate the influence of these factors on the backscattering from soil, vegetation and forestry. The modelling of soil and vegetation dielectric constants is also discussed.-Authors

Source: Scopus

Raffy, Marcel, Becker, Francois

STABLE ITERATIVE PROCEDURE TO OBTAIN SOIL SURFACE PARAMETERS AND FLUXES FROM SATELLITE DATA.

(1984) *IEEE Transactions on Geoscience and Remote Sensing*, GE-24 (3), 1984 p.

Univ Louis Pasteur, Strasbourg, Fr, Univ Louis Pasteur, Strasbourg, Fr

Abstract

Two general methods recently proposed to obtain the thermal inertia, the sensible heat flux, and the evapotranspiration flux from satellite data are summarized. In these methods, stable algorithms were used, but the stabilization coefficients presented were empirical. It is shown that optimal coefficients exist and can lead to an iterative process to calculate the thermal inertia and the fluxes with improved accuracy despite errors of measurements. Some applications using in situ data and theoretically simulated data are given as an example.

Document Type: Article

Source: Scopus

Barnes, J.C., Gendron, L.J.

Study of the combined use of data from satellite thermal infrared and microwave sensors for soil moisture detection.

(1983) 85 p.

Abstract

Satellite data for a study area in Oklahoma for two periods, one in the spring and one in the fall, were analyzed and correlated with meteorological data and soil moisture data. The thermal infrared data used in the study are the AVHRR data from the TIROS-N and NOAA-6 spacecraft; the microwave data are the SMMR data from the Nimbus-7 spacecraft. Microwave emissivities calculated using estimated soil temperatures have a trend toward high values with decreased soil moisture in both study periods. -from STAR, 22 (5), 1984

Source: Scopus

Day, R.L., Petersen, G.W.

Soil temperature investigations using satellite acquired thermal- infrared data in semi-arid regions.

(1983) 199 p.

Abstract

Thermal-infrared data from the Heat Capacity Mapping Mission satellite were used to map the spatial distribution of diurnal surface temperatures and to estimate mean annual soil temperatures (MAST) and annual surface temperature amplitudes in semi-arid east central Utah. Diurnal surface temperatures and MAST were primarily correlated with elevation-from NASA abstract E83-10355

Source: Scopus

Wilkinson, G.C., Ward, N.R., Dugdale, G., Milford, J.R.

The determination of soil moisture balances in tropical Africa by satellite infrared remote sensing - the atmospheric problem (Sahel).

(1982) *Satellite remote sensing for developing countries. Proc. symposium, Igls, 1982, pp. 103-110.*

Dept. of Meteorology, Univ. of Reading, Reading, RG6 2AU, UK.

Abstract

The Reading University TAMSAT project, set up to monitor soil moisture balances in the Sahel, is discussed. The technique of remote sensing of soil moisture content by thermal inertia mapping from space is examined. The problem of applying a radiometric correction to Meteosat infra-red channel radiances to derive ground surface temperature is considered in detail and a model is used to calculate clear column window channel

infra-red absorption.-from Authors

Source: Scopus

Kanemasu, E.T.

Use of satellite data in soil moisture and crop yield models.

(1982) 135 p.

Abstract

An evapotranspiration yield model for winter wheat was used to assess the impact of using GOES derived solar radiation estimates on plant growth models. Evapotranspiration rates were predicted using observed solar radiation estimates and those predicted from GOES using Tarpley's model and KSU's model. The yield model predicted grain yields that were similar regardless of the model used in estimating solar radiation. It appears that either of these two models (Tarpley's or KSU's) are appropriate for estimating daily solar radiation in a crop growth model such as KSU wheat model.-from STAR, 21(12), 1983

Source: Scopus

Wilkinson, G.g., Ward, N.R., Dugdale, G., Milford, J.R.

DETERMINATION OF SOIL MOISTURE BALANCES IN TROPICAL AFRICA BY SATELLITE INFRARED REMOTE SENSING - THE ATMOSPHERIC PROBLEM.

(1982) *European Space Agency, (Special Publication) ESA SP*, pp. 103-110.

Document Type: Conference Paper

Source: Scopus

Ulaby, F.T., Dobson, M.C., Moezzi, S.

Assessment of radar resolution requirements for soil moisture estimation from simulated satellite imagery.

(1982) 109 p.

Abstract

Radar simulations were performed at five-day intervals over a 20 day period and used to estimate soil moisture from a generalized algorithm requiring only received power and the mean elevation of a test site near Lawrence, Kansas. The results demonstrate that the soil moisture of about 90% of the 20-m by 20-m pixel elements can be predicted with an accuracy of $\pm 20\%$ of field capacity within relatively flat agricultural portions of the test site. Radar resolutions of 93 m by 100 m with 23 looks or coarser gave the best results. - from NASA Abstract E83-10020

Source: Scopus

Wiesnet, D.R., McGinnis Jr, D.F., Matson, M., Pritchard, J.A.

Evaluation of HCMM satellite data for estuarine tidal circulation patterns and thermal inertia soil moisture measurements.

(1981) 79 p.

Abstract

Digital thermal maps of the Cooper River (SC) and the Potomac River estuaries were prepared from heat capacity mapping radiometer (HCMR) tapes. Tidal phases were correctly interpreted and verified. Synoptic surface circulation patterns were charted by location of thermal fronts and water mass boundaries within the estuaries.- from NASA Abstract

E82-10064

Source: Scopus

Teotia, H.S., D'Hoore, J., Gombeer, R.

Soil and land use distribution over a part of northern plains (Indo-Gangentic plains) of India, based on the optical interpretation of Landsat-2 multispectral satellite imagery.

(1980) *Pedologie*, 30 (1), pp. 19-42. Cited 1 time.

Laboratorium Bodemgenese en Bodemgeografie Katholieke Universiteit, de Croylaan 42, B-3030 Leuven, Belgium.

Abstract

An identification key of tones and patterns is followed by a description of soil associations made in terms of superficial aspects (geomorphology, granulometry, vegetation cover, false colour rendering). - from Authors

Source: Scopus

HCMM satellite follow-on investigation No. 25. Soil moisture and heat budget evaluation in selected European zones of agricultural and environmental interest (Tellus project) Progress report.

(1980) 48 p.

Abstract

A simple procedure to evaluate actual evaporation was derived by linearizing the surface energy balance equation, using Taylor's expansion. The original multidimensional hypersurface could be reduced to a linear relationship

between evaporation and surface temperature or to a surface relationship involving evaporation, surface temperature and albedo. Wheat was the crop chosen for a continuous measurement campaign made in the S of Italy.-from NASA abstract E81-10057

Source: Scopus

Gombeer, R., Teotia, H.S.

General soil and land-use distribution over the Indian Subcontinent as discernible on Geos-10 satellite imagery.

(1980) *Pedologie*, 30 (1), pp. 115-125.

Katholieke Universiteit, de Croylaan 42, B-3030 Leuven, Belgium.

Abstract

A paper print image (1/10 000 000) recorded on April 6th 1979 in the visible band has been compared with climatological, geological, physiographical, botanical maps and also with the general soil map (I.A.R.I.) of India (1/6 000 000). Recognizable landscape features are listed. It is likely that GOES images can to some extent be utilized to monitor extension or regression of major flooded areas and of their effects. - from Authors

Source: Scopus

Monti, R.

Estimation of the soil composition by IR observation of the Earth by satellites

(1979) *Acta Astronautica*, 6 (11), pp. 1451-1465.

TSD, Naples, Italy

Abstract

A number of missions are in progress for Earth resources satellites to perform soil diagnosis by observing the bare soil thermal response to the heat input from the surrounding atmosphere. Heat capacity missions (and similar missions) are accomplished by measuring the soil temperature at the times of the satellite passes over the soil site. The models which are usually adopted assume that, for atmospheric conditions periodically changing during the day, the surface temperature time dependence is a function of the soil thermal inertia alone (for a dry soil). The present author has shown elsewhere that a more appropriate, two dimensional finite element modelling of the thermal behaviour of the soil, exhibits a dependence of the surface temperature time evolution on both the thermal conductivity (k) and on the volume heat capacity ($\rho\{variant\}c$) (for no evaporation at the interface). At least two independent temperature measurements are necessary in order to get information about k and $\rho\{variant\}c$. It is shown that, within the range of values of k and $\rho\{variant\}c$ of the usual soils, temperature measurements taken at two successive satellite passes may yield the necessary information on the soil thermophysical properties. Charts can be constructed which will provide information on k and $\rho\{variant\}c$ when two soil temperatures are measured at proper times. © 1979.

Document Type: Article

Source: Scopus

Fritz, E.L., Pennypacker, S.P.

Attempts to use satellite data to detect vegetative

damage and alteration caused by air and soil pollutants
(1975) *PHYTOPATHOLOGY*, 65 (10), pp. 1056-1060.

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Abstract

Data collected by a multispectral scanner on board the Earth Resources Technology Satellite was subjected to computer analysis in an attempt to detect vegetative damage primarily attributed to the atmospheric pollutant sulfur dioxide and the soil pollutant zinc emitted from a zinc smelter. Field observations and data collected by low flying aircraft were used to verify the accuracy of the maps produced from the satellite data. An eastern white pine stand that was severely damaged by sulfur dioxide could not be differentiated from a healthy eastern white pine stand because spectral differences were not large enough. The damage was still undetectable when winter data were used to eliminate interference from herbaceous and deciduous vegetation. However, the analysis did produce a character map that accurately delineated areas of vegetative alteration due to excessive zinc levels in the soil. The map depicted a distinct gradient of less damage and alteration as the distance from the smelter increased. The ERTS 1 system would be useful only on infrequent occasions when large areas of damage occur and the damage is severe enough to cause a high contrast between damaged and healthy vegetation. Even in such cases the resolution of the system would not allow an adequate evaluation of the amount of damage to the plants.

Source: Scopus

Evans, R.^a , Head, J.^b , Dirkzwager, M.^c

Air photo-tones and soil properties: implications for interpreting satellite imagery

(1975) *Remote Sensing of Environment*, 4 (C), pp. 265-280.

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Abstract

In recent publications the use of photo- or image-tone has been emphasized for identifying soil properties. In view of this the correlation of soil properties and photo-tones at a number of sites in lowland England was investigated. In the Fens of East Anglia tonal patterns are good indicators of different soils but the correlation of tonal density with specific soil properties is not good enough for these properties to be accurately predicted. At two sites in Bedfordshire photo-tone is related to a lithological pattern but at one site reflects the variability of fine sand content at the surface whereas in an adjacent field it is associated with variability in surface stoniness. At another site in Bedfordshire photo-tones are related to chalk content of the plough layer. Photo-tones therefore, indicate changes in soil surface characteristics, but these need not reflect changes at the same level of importance either for soil classification and mapping or agricultural purposes. This must be borne in mind when interpreting satellite imagery. The types of pattern discussed in this paper are widespread in lowland England but resolution of satellite imagery is not yet

sufficient for these patterns to be detected and recognized. © 1976.

Document Type: Article

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